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**Facilities Plan Administrative Report
for Lead-Deadwood, Sanitary District
No. 1, Deadwood, South Dakota**

CH2M/Hill, Denver, Colo

May 76

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ADMINISTRATIVE REPORT

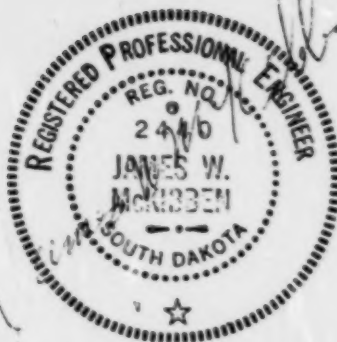
FACILITIES PLAN

LEAD-DEADWOOD SANITARY DISTRICT NO.1
DEADWOOD, SOUTH DAKOTA



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FACILITIES PLAN
ADMINISTRATIVE REPORT
for
LEAD-DEADWOOD SANITARY DISTRICT NO. 1
DEADWOOD, SOUTH DAKOTA



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May 1976

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ACKNOWLEDGMENTS

During the facilities planning procedure, several review meetings were held with various local, State and Federal agencies and public interest groups. The major objectives of these review sessions were to agree upon selective alternative wastewater management systems to be evaluated and to keep the various groups fully informed about the progress of the Facilities Plan. The following agencies and local groups attended the various review meetings and provided invaluable input to the direction of the facilities planning procedure:

- Lead-Deadwood Sanitary District No. 1 (District)
- Homestake Mining Company (HMC)
- Environmental Protection Agency, Region VIII (EPA)
- South Dakota Department of Environmental Protection (DEP)
- U.S. Forest Service
- Bureau of Land Management (BLM)
- Soil Conservation Service (SCS)
- Farmers Home Administration (FmHA)
- United Steel Workers of America, Local 7044
- Sixth District Council of Local Governments
- State Planning Bureau
- Save Centennial Valley Association

FACILITIES PLAN REPORT ORGANIZATION

This Facilities Plan study report consists of four documents:

- Administrative Report. The Administrative Report is a summary of the significant findings of the Facilities Plan and Environmental Assessment. It is a concise presentation of the selected wastewater management system, major background information, the most feasible wastewater management alternatives, and the basic issues surrounding those alternatives.
- Technical Report. The Technical Report contains supportive technical information for the Administrative Report and Environmental Assessment and documents the steps and decisions that evolved during the Facilities Plan study.
- Environmental Assessment. The assessment is an analysis of the environmental aspects of the proposed project, augmented by a discussion of the alternatives considered. This report is intended to supplement the Facilities Plan and to assist the U.S. Environmental Protection Agency's analysis of the ramifications of the project as required by the National Environmental Policy Act.
- Appendices. The Appendices contain detailed background material and copies of the various task reports developed during the facilities planning procedure. They document the basic data supporting the issues and conclusions discussed in the Administrative and Technical Reports. Copies of the Appendices are available for inspection at the Lead-Deadwood Sanitary District No. 1.

The complete Facilities Plan includes the revision of the draft Facilities Plan study report, documentation of public hearings, and a detailed description of the selected wastewater management alternative.

Throughout this report a distinction is made between the water quality objective, water quality standards or criteria, and effluent limitations. The water quality objective is the State's beneficial use designation of a cold water fishery for Whitewood Creek. The water quality criteria are the parameters determined by the State to achieve the water quality objective. The effluent limitations (based on the water quality criteria) are the discharge parameters specified in the National Pollution Discharge Elimination System (NPDES) Discharge Permits.

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Section 1

SUMMARY

RESULTS OF FACILITIES PLAN STUDY

A secondary wastewater treatment plant to be located in lower Deadwood near the rodeo grounds has been selected as an interim solution to the Lead-Deadwood area pollution problem. This treatment system was chosen after the development and evaluation of three rounds of wastewater management alternatives during the Facilities Plan study conducted by the Lead-Deadwood Sanitary District No. 1 (the District).

The first two rounds of alternatives were developed with the goal of achieving the State water quality permanent cold water fishery objective for Whitewood Creek. The system recommended on this basis was a lower Deadwood advanced wastewater treatment (AWT) plant. To meet the effluent limitations established under the cold water fishery objective, a minimum of advanced wastewater treatment was required.

Following the second round alternatives evaluation, a draft Facilities Plan report was completed in July 1975 to present the study findings and the recommended system. However, the draft also noted several concerns about the ability to implement the AWT plant or any system that would meet the required effluent limitations. Also, the basic planning issues discussed at the end of this Administrative Report were raised in the draft.

The District expressed the following three concerns about the alternatives developed so far:

1. The alternatives would be too costly and would therefore not be approved by the District's residents.

2. The less costly alternatives involved a lower treatment that would not meet the required effluent limitations. Furthermore, it was questioned whether implementing the treatment level required to meet the effluent limitations would assure the establishment of a cold water fishery in Whitewood Creek because of uncertainties associated with the stream's hydrological data and the unknown effects of the existing tailings deposits.
3. Construction of a wastewater treatment facility in lower Deadwood would be unacceptable due to visual and odor problems characteristic of conventionally designed wastewater treatment facilities.

To alleviate these concerns, the draft report considered the investigation of compromise solutions. These compromise solutions would have lower costs but would not meet the set effluent limitations. Implementation of any compromise alternative would require modifying the permanent cold water fishery objective.

On the basis of the information in the draft Facilities Plan, the District sought to get the effluent limitations lowered. Two legal actions resulted. First, the State of South Dakota changed the stream classification of Whitewood Creek below Deadwood from a permanent to a marginal cold water fishery. Second, on 5 March 1976, the State Department of Environmental Protection (DEP) issued an order that waived the water quality objective to allow secondary treatment of the District's wastes with the provision for upgrading the treatment system by 1 July 1988 to meet the cold water fishery objective if future evidence shows that Whitewood Creek will rehabilitate itself by that date.

This order alleviated the concern about meeting the required effluent limitations. Also, the order helped with the concern about cost by allowing the consideration of less costly lower level treatment. Costs were further reduced by revising the sewage collection system. Specifically, planned service to the outlying areas of Terraville, Deer Mountain, Terry Peak/Bald Mountain, and Nevada Gulch/Fantail was eliminated because of the high cost associated with serving a proportionately small number of homes. The District also reviewed the number of homes to be served by the revised collection system. As a result, the homes to be served increased from 2,500 to 3,000.

Finally, the concern about aesthetic and odor impacts was considered in the development of the compromise solutions, or third round alternatives. Two systems were included in a final competitive evaluation, as discussed later in Section 5. One of the systems is the selected lower Deadwood secondary treatment plant, which was originally a second round alternative. This system has been modified as indicated below to meet the concerns about visual and odor problems:

- The plant will include a dechlorination and effluent aeration facility in order to meet the stream's chlorine water quality standard.
- The entire plant will be housed in a building in order to decrease the visual impact on lower Deadwood and to facilitate the collection and control of odors.
- The plant will include odor control equipment to cleanse any odors originating from the treatment facility.

On the basis of the third round competitive evaluation and meetings with Federal and State agencies, the lower Deadwood

secondary treatment plant has been selected as the most cost-effective and environmentally sound interim alternative. This system will meet the new required effluent limitations and will be a major step toward solving the Lead-Deadwood area pollution problem.

The proposed project will extend the sewage collection system with transmission to a 2.33-mgd biological treatment plant to be built at lower Deadwood, 1/4 mile north of the rodeo grounds. The project has a 20-year design life and a present worth of \$7.8 million. Total project cost is estimated to be \$5.4 million with a local cost of \$1.2 million. The total annual cost will be about \$346,000, and the estimated monthly household cost will be \$9.61. The project has been sized for a 10,800 population. The project service area, collection system and treatment plant location are shown on Figure 1. The collection system and treatment plant components of the selected wastewater management system are described in the following sections.

COLLECTION SYSTEM

The proposed wastewater collection system will serve Lead, Deadwood, and several surrounding areas presently in the District. Approximately 48,000 feet of new interceptor will be built, and a new 1,600-foot transmission line will be installed from lower Lead to the lower Deadwood plant site. The outlying areas of Deer Mountain, Terraville, Terry Peak/Bald Mountain, and Nevada Gulch/Fantail are not included because of the high cost associated with serving the relatively small number of homes in these areas.

Outlying areas included in the proposed collection system are combined into three groups. The Deadwood Creek system will provide service to existing homes in the Deadwood Creek drainage basin, including Central City, Blacktail, and Glendale. The south Lead system will consist of five small pump stations,

identified on Figure 1, to discharge the south Lead flows into the existing Lead collection system. The third major group consists of the Pluma, Strawberry Creek and Grizzly Gulch collection systems. The proposed collection system is shown on Figure 1.

The interceptor sewer additions to the wastewater collection system will be gravity sewers of either vitrified clay or concrete pipe. Standard construction methods will be used for trench excavation, pipe installation, backfilling and repaving when necessary.

LOWER DEADWOOD SECONDARY TREATMENT PLANT

The District's wastewaters will be treated in a secondary treatment plant near the rodeo grounds in lower Deadwood. The treatment plant site plan is shown on Figure 2, and the layout of the unit processes is presented on Figure 3. The proposed treatment facility will be entirely enclosed within a building to lessen the visual and odor impacts. The treatment facility features are described below.

Raw Sewage Pump Station

A raw sewage pump station with a capacity of 7.0 mgd will lift the wastewater from the gravity interceptor to the pretreatment system. The pump station may be located near the rodeo grounds bridge. It will contain its own standby power system to prevent bypassing flows during power outages.

Rotary Screens

Rotary screens will collect and remove large solids from the raw wastewater. The effluent will flow by gravity to the main plant pump station. The screened solids will be conveyed to a waiting dump truck for disposal in a sanitary landfill.

Main Plant Pump Station

The main plant pump station will blend the pretreated effluent with return flows from the fixed film biological reactors, supernatant from the aerobic digesters, and sludge recycled from the secondary clarifiers. Pumping capacity will be about 7.8 mgd. This pump station will lift the flow to the top of the activated biological filters.

Activated Biological Filter System

The activated biological filter system (ABF) is a combination of the trickling filter and activated sludge processes. During this secondary treatment, organic material and ammonia will be oxidized and the organic matter will be consumed by bacteria. Wastewater will be distributed over the top of the filter media by a fixed nozzle distribution system. A portion of the underflow will be recycled, along with the settled sludge from the secondary clarifiers, to the main plant pump station. Effluent from the filter tower will flow by gravity into two aeration basins, where the organic matter will be further broken down by bacteria. Design criteria for the ABF system are listed on the table below.

ACTIVATED BIOLOGICAL FILTER SYSTEM DESIGN CRITERIA

Filter Towers

Number of Towers	1
Average BOD Load	1,920 lbs BOD/day
Average Volumetric BOD Loading	145 lbs/1,000 ft ³ /day

Aeration Basins

Number of Basins	2
Total Liquid Volume	0.60 million gallons
Detention Time	
Average Daily Flow of 2.33 mgd	6.2 hrs.
Maximum Daily Flow of 3.0 mgd	4.8 hrs.
Average Waste Sludge Production (Dry Solids)	1,000 lbs/day
Average Sludge Recycle Rate	50%

Air moves through the towers by natural air convection currents. Unless the towers are severely overloaded, this air movement is sufficient to avoid any potential odor problems. However, fans will be provided to increase the amount of air moving through the towers. The exhaust air will be scrubbed to further control odors. A permanganate or ozone scrubbing system will be used.

Blowers located in the main plant pump station will supply air for the aeration system in the aeration basins and aerobic digesters.

Secondary Clarifiers

Suspended solid material will be removed by gravity in two circular clarifiers. To prevent sludge denitrification and its resulting floating sludge, rapid sludge removal mechanisms are to be employed.

Scum and grease will be removed from the surface of the secondary clarifiers with double scum skimmer arms. To remove the scum from the treatment process, scum pumps will deliver the scum from a common collection pit to either the aerobic digesters or a hopper for direct disposal in a sanitary landfill. Facilities will be included to dewater the clarifiers, aeration basins, aerobic digesters, and air flotation thickener units.

Disinfection and Dechlorination Systems

For disinfection, 5 to 8 mg/l of chlorine will be added to the secondary clarifier effluent before it is discharged into a 1-hour detention time contact basin. Plant water will be withdrawn from this basin. It can be used for chlorine injection, pump seals, irrigation, scum spray control, cooling, washdown, and other miscellaneous plant uses.

Sulfur dioxide will be used for dechlorination. The effluent pH will be monitored and adjusted with sodium hydroxide. Both of these chemicals will be applied in the effluent end of the contact basin.

A small blower station will provide air for reaeration of the chlorine contact chamber effluent in the effluent pipe.

Aerobic Sludge Digestion

Waste sludge from the secondary clarifiers will be pumped to two parallel aerobic digester basins. The design criteria for the digesters are presented on the table below. Based on a 1-percent underflow solids concentration from the clarifiers, the aerobic digesters will have a 20-day detention time. The aerobic digesters will allow supernatant to be decanted from the solids, thereby increasing the solids content and sludge detention time.

AEROBIC DIGESTERS DESIGN CRITERIA

Number	2
Volume	18,900 ft ³
Detention Time	20 days
Solids Under Aeration	1%

Sludge Thickening

To decrease the volume of sludge that must be disposed of in a nearby sanitary landfill, an air flotation thickening system will be used with the design criteria shown on the following table. The sludge should be thickened from the 1 percent found in the aerobic digesters to 4 or 5 percent dry solids in the float cake.

To assist in the dewatering of the sludge, facilities for storing, mixing, and adding polyelectrolytes will be provided. A total of 4 to 5 pounds per day or 0.8 tons per year will be required.

AIR FLOTATION THICKENER DESIGN CRITERIA

Number (1 standby)	2
Area	60 ft ²
Dimensions	10 ft x 6 ft x 10 ft
Solids Loading	2.0 lbs dry solids/ft ² /hr
Polyelectrolytes Added	10 lbs/ton dry solids
Effluent Recycle Rate	100%

Administration and Laboratory Area

An administration and laboratory area will house a laboratory with automatic sewage sampling equipment, sample storage, office space, lockers and restrooms, maintenance equipment, a storage area, plant instrumentation and monitoring equipment. A workshop and storage area will also be provided as part of the facility.

Electrical System

Electrical power for the treatment plant can be obtained from Black Hills Power and Light, who serves the site. Points of service will be established near the raw sewage pump station. Standby generation equipment of sufficient capacity to maintain the operation of the entire plant during power outages will be provided.

Section 2
EXISTING CONDITIONS

Figure 4 defines the planning area considered by the District in the facilities planning procedure. The planning area can be generally described as the area lying tributary to Whitewood Creek immediately below Deadwood. The only part of the study area not in the Whitewood Creek basin is a new subdivision near the Terry Peak ski area that lies in the Spearfish Creek drainage basin.

The Lead-Deadwood area discharges into Whitewood Creek and its tributaries. This stream system has not only a local, but also a regional impact. Effects of the study area's pollution have been measured as far as 110 miles downstream, along the Belle Fourche and Cheyenne Rivers, shown on Figure 5.

The pollution sources within the Lead-Deadwood area are identified on Figure 6. The outlying areas of Deadwood Creek, Grizzly Gulch/Strawberry Creek, Nevada Gulch/Fantail Creek, Terry Peak/Bald Mountain and Deer Mountain represent minor sources of water pollution. These areas are presently unsewered with septage and untreated wastewater being discharged into the area's streams. Contamination of private water wells in the Nevada Gulch area has been documented by the county sanitarian. The area's three major pollution sources are the discharges from the Cities of Deadwood and Lead and from Homestake Mining Company (HMC).

Deadwood and Lead discharge both untreated storm water and untreated domestic wastewater into area streams. The City of Deadwood has separate storm sewer and domestic wastewater collection systems that discharge untreated wastewater at several points into Whitewood Creek. The major sanitary discharge point is located near the rodeo grounds in lower Deadwood. The City of Lead has a combined storm sewer and

domestic wastewater collection system that discharges untreated wastewater into Gold Run. Gold Run discharges into Whitewood Creek in the vicinity of Pluma. Several small areas of Lead have Imhoff and septic tanks that discharge partially treated wastewater into area streams.

A third major pollution source in the Lead-Deadwood area is the discharge of tailings and industrial waste from HMC. HMC's waste is the area's largest suspended solids, cyanide, and heavy metals pollution source. At present, HMC discharges approximately 2,700 tons to 3,000 tons per day of tailings. These tailings, along with process water, are discharged into either the lower reaches of the Lead combined collection system or Gold Run Creek. HMC's tailings, combined with those of other previously operating mills, have created an estimated 199 acres of deposits along Whitewood Creek and 2,456 acres of deposits along the Belle Fourche River.

The water quality baseline data on the study area's streams have not been definitively established. The data summarized on Tables 1 and 2 have been compiled from previous reports and are based on the best information available. Table 1 shows the water quality in the area's streams above the major industrial and municipal discharges, and Table 2 shows the water quality below the discharges.

Table 1
EXISTING STREAM QUALITY DATA UPSTREAM OF
HOMESTAKE MINING COMPANY AND MUNICIPAL DISCHARGES (1)

Parameter	Whitewood Creek Above Pluma			Whitewood Creek Above Whitetail Creek		Whitetail Creek Above Whitewood Creek		Deadwood Creek Above Deadwood Source B		Grizzly Gulch Creek Source D	
	Source A	Source B	Source C	Source A	Source A	Source A	Source A	Source B	Source B	Source D	Source D
Total Suspended Solids	6	--	--	1	3-6	0	--	--	--	0	--
Total Iron	0.16	0.9-5.3	0.26	0.14	0.77-0.78	0.31-0.5	--	0.31-0.5	--	<0.01	--
Total Cyanide	N.D. (2)	<0.02	--	N.D.	N.D.	<0.02	--	<0.02	--	--	--
Total Arsenic	--	0.013-1.0	0.01	--	--	0.0084-0.012	--	0.0084-0.012	--	--	--
Total Cadmium	--	0.002-0.05	--	--	--	0.001-0.05	--	0.001-0.05	--	<0.01	--
Total Chromium	--	--	N.D.	--	--	--	--	--	--	<0.02	--
Total Copper	--	0-0.03	0.15	--	--	0-0.01	--	0-0.01	--	<0.02	--
Total Lead	--	0-0.56	N.D.	--	--	<0.2-0.65	--	<0.2-0.65	--	<0.10	--
Total Mercury	--	0.0002-0.0017	0.0013	--	--	<0.0002-0.0014	--	<0.0002-0.0014	--	<0.2	--
Total Nickel	--	--	N.D.	--	--	--	--	--	--	<0.03	--
Total Zinc	--	<0.02-0.08	0.13	--	--	<0.01-1.11	--	<0.01-1.11	--	<0.001-0.007	--
pH (units)	7.8	--	--	7.8	7.3-7.7	--	--	--	--	7.51-7.70	--
Turbidity (JTU)	5	--	--	7	7-8	--	--	--	--	--	--
Chloride	120	--	1	175	102-157	--	--	--	--	4.59-5.67	--
Manganese	--	--	N.D.	--	--	--	--	--	--	--	--
Molybdenum	--	--	N.D.	--	--	--	--	--	--	--	--

(1) Sample results are in mg/l unless otherwise noted and are taken from the following sources:

- A An Evaluation of Pollution in the Belle Fourche and Cheyenne Rivers Due to Wastes Carried by Whitewood Creek. C. A. Thilenius, 1965. Grab sampled February 1963. Results in ppm.
- B Report on Pollution Affecting Water Quality of Cheyenne River System. EPA, 1971. Grab sampled March and June 1971.
- C Investigations of Gold Run Creek Outfall Water. Colorado School of Mines Research Institute, 1974. Grab sampled October 1973. Filtered: 0.45µ.
- D Grizzly Gulch Supportive Data. CH2M HILL, 1974. Grab sampled October 1974.

(2) Not detected.

Table 2
EXISTING STREAM QUALITY DATA DOWNSTREAM OF
HOMESTAKE MINING COMPANY AND MUNICIPAL DISCHARGES (1)

Parameter	Gold Run Creek Above Whitewood Creek		Whitewood Creek In Lower Deadwood Area		Whitewood Creek Near Whitewood Source A
	Source A	Source C	Source A	Source B	Source C
BOD ₅	25-70	--	10-100	--	--
Total Suspended Solids	804	--	12,570-15,466	--	--
Total Iron	--	N.D. (2)	--	225-428	--
Total Cyanide	0.6-9.1	--	0.69-2.1	0.50-1.1	0.69
Total Arsenic	--	0.34	--	0.23-1.70	--
Total Cadmium	--	--	--	0.003-<0.05	--
Total Chromium	--	N.D.	--	--	--
Total Copper	--	1.3	--	0.11-0.18	0.03
Total Lead	--	N.D.	--	<0.2-0.70	N.D.
Total Mercury	--	0.001	--	0.0021-0.0080	--
Total Nickel	--	0.02	--	--	N.D.
Total Zinc	--	0.026	--	0.45-0.60	0.015
pH (units)	8.0-11.7	--	8.4-8.8	--	8.2-8.4
Dissolved Oxygen	4.7-6.1	--	1.5-3.7	--	--
Temperature (° F)	61-63	--	61-72	--	69-77
Manganese	--	N.D.	--	--	0.02
Molybdenum	--	0.013	--	--	N.D.
Fecal Coliform (No./100 ml)	2.4(10) ⁶ -46(10) ⁶	--	0.43(10) ⁶ -11(10) ⁶	--	--

(1) Samples results are in mg/l unless otherwise noted and are taken from the following sources:

- A Report of Water Pollution Studies, Gold Run Creek-Whitewood Creek, Belle Fourche River-Cheyenne River. South Dakota State Department of Health, 1960. Composite sampled June and July 1959. Results in ppm.
- B Report on Pollution Affecting Water Quality of Cheyenne River System. EPA, 1971. Composite sampled March, June, and July 1971.
- C Investigation of Gold Run Creek Outfall Water. Colorado School of Mines Research Institute, 1974. Grab sampled October 1973. Filtered: 0.45µ.

(2) Not detected.

Section 3

EFFLUENT LIMITATIONS AND TREATMENT REQUIREMENTS

The effluent limitations established in the District's and HMC's National Pollution Discharge Elimination System (NPDES) Discharge Permits, issued in January of 1975, are shown on Table 3. The District's NPDES Discharge Permit has two sets of effluent limitations: one for the District by itself, and a second for the District and HMC in a combined collection and treatment system.

The permits' effluent limitations are based on South Dakota Surface Water Quality Standards, which are more stringent than the Federal requirements. The State has specific water quality standards for various beneficial use classifications. When the Discharge Permits were set, Whitewood Creek was classified as a permanent cold water fishery, as shown on Table 4. The beneficial uses designated for the other streams in the study area are also listed on Table 4. The Discharge Permits have been set with the objective of achieving the high water quality necessary to establish a permanent cold water fishery in Whitewood Creek. Subsequently, Whitewood Creek below Deadwood has been reclassified from a permanent to a marginal cold water fishery, as noted on the table and discussed below.

In estimating effluent limitations, the diluting effect of the stream's flow on discharges is accounted for by calculating low flows. However, because Whitewood Creek has no permanent gauging station, the EPA and South Dakota Department of Environmental Protection (DEP) estimated the stream's low flows using historical flows recorded for nearby Spearfish Creek. The Spearfish Creek flows were adjusted by the ratio of the Whitewood Creek and Spearfish Creek drainage areas. This is the best method available for estimating Whitewood Creek's flows without performing an extensive, time-consuming

Table 3
EFFLUENT LIMITATIONS IN THE
NATIONAL POLLUTION DISCHARGE ELIMINATION SYSTEM DISCHARGE PERMITS
(unit mg/l except as noted)

<u>Parameter</u>	<u>Lead-Deadwood Sanitary District No. 1 (LDSD #1) SD-0020796</u>	<u>Combined LDSD #1-HMC SD-0020796</u>	<u>Homestake Mining Company (HMC) SD-0000043</u>
Permit No.			
BOD ₅			
Average	10	10	10
Maximum	17.5	17.5	17.5
Total Suspended Solids			
Average	10	10	10
Maximum	17.5	17.5	17.5
Fecal Coliform			
30-day Average MPN/100ml	200	200	-
7-day Average MPN/100ml	400	400	-
Total Residual Chlorine	0.05	0.05	0.02
Ammonia-Nitrogen	0.6	1.0	0.6
pH Units	6.0 - 9.0	6.0 - 9.0	6.5 - 9.0
Total Iron	-	0.3	0.3
Free Cyanide	-	0.008	0.005
Total Cyanide	-	0.03	0.02
Total Arsenic	-	0.16	0.1
Total Cadmium	-	0.005	0.003
Total Chromium	-	0.08	0.05
Total Copper	-	0.03	0.02
Total Lead	-	0.08	0.05
Dissolved Lead	-	0.022	0.015
Total Mercury	-	0.0003	0.0002
Total Nickel	-	0.31	0.2
Total Silver	-	0.0003	0.0002
Total Zinc	-	0.06	0.04
Oil and Grease	-	10.0	10.0
Undisassociated Hydrogen Sulfide	-	0.003	0.002

Table 4
BENEFICIAL USES DESIGNATED FOR
STREAMS WITHIN STUDY AREA^{(1) (2)}

<u>Stream</u>	<u>From</u>	<u>To</u>	<u>Beneficial Uses⁽³⁾</u>
Whitewood Creek	Belle Fourche River	I-90 near City of Whitewood	5, 8
Whitewood Creek	I-90 near City of Whitewood	Northern Deadwood City Limits	2 ⁽⁴⁾ , 7, 8
Whitewood Creek	Northern Deadwood City Limits	Headwaters	2, 7, 8
Whitewood Creek (Identified as Englewood Creek in State Standards)	Confluence with Whitetail Creek	Headwaters	3, 8
Whitetail Creek (Identified as Kirk Creek in State Standards)	Whitewood Creek	Headwaters	3, 8
Grizzly Creek	Whitewood Creek	Headwaters	3, 8

(1) All streams within the State are assigned beneficial uses 9 and 10.

(2) Taken from Rules of the Board of Environmental Protection, Article 34:04, Water Pollution Program. State of South Dakota, 1974.

(3) See Table 2.2 for definition of beneficial uses.

(4) This reach of Whitewood Creek has not been reclassified as a cold water marginal fishery, or Beneficial Use Classification 3.

and expensive hydrologic study. The flows used in establishing the effluent limitations are only estimates.

The background water quality used to establish the effluent limitations was also estimated. Although a large amount of data has been collected concerning the background water qualities of the area's streams, characterizations including the magnitude and frequency of quality variations are not available. With few exceptions, most of the analytical data are based on grab samples taken at random points throughout the year. These data reflect a wide variation in water quality.

The effluent limitations specified in the Discharge Permits were the goals of the Facilities Plan study up to the two recent legal actions that have lowered the required effluent levels. On the basis of the Discharge Permit requirements, two rounds of wastewater treatment alternatives had been developed and evaluated. Subsequently, a third round of alternatives has been considered to reflect the legal changes.

The first change was a reclassification of Whitewood Creek below Deadwood to a marginal cold water fishery, as indicated earlier. The second legal action involved an order issued by the State DEP on 5 March 1976, which lowered the required treatment level. This order waived the water quality objective to allow secondary treatment of the District's wastes with the provision for upgrading the treatment system by 1 July 1988 to meet the marginal cold water fishery objective if future evidence shows that Whitewood Creek will rehabilitate itself by that date. The order is presented in the following pages and is the basis for selecting the secondary treatment plant as an interim solution to the area's pollution problem.

Before the Secretary
Department of Environmental Protection
State of South Dakota

In the matter of Lead-Deadwood
Sanitary District No. 1,
P.O. Box 51, Deadwood,
South Dakota 57732
Norman Bakke, as President
James Dunn, as Vice-President
and Renaldo Gallo, as Secretary
of the District's Board of
Trustees

ORDER

This matter having come on for hearing before me, David V. Vrooman, Hearing Officer, at Deadwood, South Dakota, on March 1, 2, 3, and 4, 1976, the District having been represented by Jon Mattson, and the Department of Environmental Protection by Lawrence W. Kyte and Warren R. Neufeld, and after review of the pleadings, exhibits, stipulations, and testimony,

IT IS HEREBY ORDERED,

1. That the District and Board construct and have in operation a sewage treatment plant for all domestic wastes generated within the District which will be discharged into Whitewood Creek or its tributaries that will give all wastes secondary treatment by July 1, 1978.

2. That the District construct, at the same time that the construction outlined in Part 1 of this opinion to be completed also by July 1, 1978, additional facilities which will prevent the effluent from causing ammonia nitrogen to exceed 3.0 mg/l at any time in Whitewood Creek and total chlorine residual to exceed 0.02 mg/l. Although this Order requires that the construction of this portion must be completed by July 1, 1978, this portion of the treatment facility need not be put into operation by the District before the latter of the following two dates (a) July 1, 1979, or (b) when in the opinion of the Secretary of the Department of Environmental Protection the operation of this portion of the system will aid the rehabilitation process of the beneficial uses assigned to Whitewood Creek.

3. In order to assure and monitor steps for compliance with the July 1, 1978, date the following interim steps are required:

- (a) The District and Board shall make the selection of an approvable wastewater management system by April 1, 1976.

(b) The District and Board shall complete and submit a final facilities plan and environmental assessment on the selected wastewater management system to EPA and SDDEP by May 15, 1976.

(c) The District and Board shall commence construction by April 1, 1977.

4. That the District, and the Board be required to have constructed and operating by July 1, 1988, a sewage treatment plant for all domestic wastes generated within the District, which will be discharged into Whitewood Creek, or its tributaries which will insure that such treated effluent does not violate South Dakota Water Quality Standards applicable to Whitewood Creek;

5. That any sewage treatment plant to be constructed by the district shall not discharge effluents into any portion of the water of Whitewood Creek or its tributaries which have not previously been affected by the municipal or industrial discharges from within the district if such discharges will cause a violation of Water Quality Standards or significant degradation in such segments or water;

6. That the District and the Board be allowed an opportunity to petition the secretary prior to July 1, 1985, for a re-hearing and present new evidence which would show that avoidance of compliance with State Water Quality Standards by the District would be justified beyond July 1, 1988, as required by part four of this order. Such evidence would have to show that the affected area of Whitewood Creek will not have rehabilitated itself by July 1, 1988, or soon thereafter, to the extent that it will be suitable as cold water marginal fish life propagation waters. This evidence could include but not necessarily be limited to, stream or biological data. Further, that this order shall be subject to modification and extension of the July 1, 1988, deadline for compliance by the Secretary or the Board of Environmental Protection. Such modification or extension of time for requiring additional treatment shall be based upon a reasonable estimate shown as to when rehabilitation from previous waste discharges will have been sufficient to allow establishment of a cold water fishery, or time needed for additional study to determine a reasonable estimate of the time needed for recovery.

7. The District and the Board shall submit to the South Dakota Department of Environmental Protection a report on the results of effluent or water quality samples to be taken by the District or its agents at least semiannually; and

8. The secretary may modify the time schedules set out in this order upon a timely petition and a showing by the District and the Board that there is good cause for revision because of delays in construction due to work stoppage, delays in receiving equipment or materials ordered by the

contractor, unusual weather conditions or other construction and implementation problems beyond the control of the District and its Board and that the District has acted diligently and in good faith to comply with this order.

Signed and dated this 5th day of March, 1976.

(signed)

DAVID V. VROOMAN
Hearing Officer

Suite 517 101 S. Main
Sioux Falls, South Dakota 57102

CERTIFICATE OF SERVICE

I, David V. Vrooman, do hereby certify that a true and correct copy of the above and foregoing Order in the above entitled matter was served upon Jon Mattson, attorney for Lead-Deadwood Sanitary District No. 1, 696 Main Street, Deadwood, South Dakota 57732, and Lawrence W. Kyte, attorney for the Department of Environmental Protection, Room 415, Foss Office Bldg., Pierre, South Dakota 57501; and that said copies were duly served by first class mail, postage prepaid, this 5th day of March, 1976.

(signed)

DAVID V. VROOMAN

Section 4
PLANNING PROCEDURE

OBJECTIVES

The objectives of the Facilities Plan undertaken by the District were to define wastewater management design criteria, develop alternative management systems, and select an optimum treatment process that will minimize economic investment and maximize social and environmental benefits.

EVALUATION CRITERIA

The following criteria were set for the development and evaluation of alternative wastewater management systems:

- Ability to achieve the required effluent limitations.
- Economic feasibility in terms of the District's financial capabilities and in terms of costs versus benefits.
- Flexibility to be upgraded to meet higher treatment requirements, when necessary with minimum additional costs (both capital and operating).
- Environmental impacts.
- Acceptability to the local community.

Early in the planning process the District expressed concern about the cost of implementing the high treatment level systems required to achieve the effluent limitations based on the State's permanent cold water fishery objective for Whitewood Creek. Therefore, two lower levels of treatment were also analyzed during the first two rounds of alternatives in an

effort to identify compromise solutions. A comparison of all three treatment levels helped define the relative economic and environmental impacts and cost-benefit ratio of implementing a high treatment level to meet the effluent limitations. The three treatment levels can be generally defined as follows:

- Level 1 treatment would satisfy the NPDES Discharge Permit and the South Dakota Surface Water Quality Standards for a permanent cold water fishery objective.
- Level 2 treatment would be secondary treatment plus effluent filtration and would satisfy neither the NPDES Discharge Permit issued to the District nor the State Surface Water Quality Standards.
- Level 3 treatment would be secondary treatment and also would satisfy neither the NPDES Discharge Permit nor the State standards.

The effluent characteristics for each of these treatment levels are given on Table 5. Adoption of either Level 2 or 3 required modification of the effluent limitations then established under the permanent cold water fishery objective. If a system producing Level 2 or 3 treatment were to be implemented, it must have the flexibility to be upgraded to a higher treatment level to achieve the zero discharge goal of 1985, as required by Public Law 92-500.

DEVELOPMENT

After the establishment of objectives and evaluation criteria, the development of the Facilities Plan involved five phases. This five-phase development is shown on Figure 7 and described below. All five phases have been completed.

Table 5
TREATMENT LEVEL EFFLUENT CHARACTERISTICS

Parameter (1)	Level 1 Required Effluent Limitations (2)	Level 2 Secondary Treatment Plus Filtration (3)	Level 3 Secondary Treatment (3)
BOD ₅			
Average	10	10	30
Maximum	17.5	17.5	45
Total Suspended Solids			
Average	10	10	30
Maximum	17.5	17.5	45
Fecal Coliform (MPN/100ml)			
30-day Average	200	200	200
7-day Average	400	400	400
Coliform (MPN/100ml)			
30-day Average	1000	1000	1000
7-day Average	2000	2000	2000
Dissolved Oxygen	7	6	--
Total Dissolved Solids	1500	1500	1500
Total Alkalinity (CaCO ₃)	750	--	--
Total Residual Chlorine	0.05 (0.02) (4)	0.05	1.0
Chlorides	100	--	--
Ammonia as N	1.0 (0.6)	--	--
NO ₃	50	--	--
pH Units	6.6 - 8.6	6.0 - 9.0	6.0 - 9.0
Turbidity (JTU)	10	50	50
Total Iron	0.3 (0.2)	--	--
Free Cyanide	0.005 (0.002)	--	--
Total Cyanide	0.03 (0.02)	--	--
Total Arsenic	0.16 (0.1)	--	--
Total Cadmium	0.005 (0.003)	--	--
Total Chromium	0.08 (0.05)	--	--
Total Copper	0.03 (0.02)	--	--
Total Lead	0.08 (0.05)	--	--
Dissolved Lead	0.022 (0.015)	--	--
Total Mercury	0.0003 (0.0002)	--	--
Total Nickel	0.31 (0.2)	--	--
Total Silver	0.0003 (0.0002)	--	--
Total Zinc	0.06 (0.04)	--	--
Oil and Grease	10.0	--	--
Undissociated Hydrogen Sulfide	0.003 (0.002)	--	--
Conductivity (micromhos/cm)	1500	--	--
Na Adsorption Ratio (Units)	10	--	--

(1) All units are mg/l except as noted.

(2) Discharge to Whitewood Creek at South Deadwood.

(3) Would not satisfy cold water fishery water quality objectives.

(4) Values in () are required for discharge into Whitewood Creek at Pluma.

1. Definition of subsystem components. During this phase many components or subparts of a wastewater management system were defined and analyzed. Components that appeared impractical were eliminated from further consideration. Components common to numerous wastewater management systems were identified and analyzed to reduce the number of alternative systems to be developed. Through this process a set of component parts were clearly defined for combination into wastewater management alternatives.
2. Definition of alternative wastewater management systems. Numerous alternative wastewater management systems were defined during this second phase, using various combinations of the subsystem components. They are indicated on Figure 7.
3. Preliminary wastewater management systems evaluation. The objective of this phase was to reduce the number of alternative systems under consideration by a preliminary evaluation of system costs, capabilities, environmental impacts, and implementation arrangements. As a result of this first round analysis, three wastewater management alternatives were selected for an additional competitive evaluation.
4. Competitive evaluation of selected wastewater management systems. A detailed second round evaluation was made of the three wastewater management alternatives determined to be the most viable during the preliminary screening. The competitive evaluation reviewed and identified additional tradeoffs associated with implementing each alternative.

As a result of the preliminary competitive evaluation, all of the selected wastewater management systems

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Section 5
EVALUATION OF ALTERNATIVES

The following two wastewater management system alternatives were selected for the final competitive evaluation:

- Lower Deadwood Secondary System (LDSS).
- Grizzly Gulch Lagoon System (GGLS).

A summary of the engineering, economic and environmental comparison of these two alternatives is presented below. A more thorough analysis of the two alternative systems is given in the Environmental Assessment. The costs and effluent characteristics associated with the two systems are given on Tables 6 and 7, respectively.

LOWER DEADWOOD SECONDARY SYSTEM

This system is described in detail in Section 1 and shown on Figures 1, 2, and 3.

Advantages

- The LDSS is significantly less costly than the GGLS. Present worth of the LDSS is \$7.8 million, while present worth of the GGLS is \$10.8 million.
- Although both alternatives provide equal opportunity for addition of advanced treatment, the LDSS provides better opportunity for expanding facility capacity to accommodate increased flows.
- The plant would discharge below Deadwood, so revision of stream standards and the DEP order of 5 March 1976 would not be necessary. Because plant effluents

Table 6

COMPARATIVE COST SUMMARY

	<u>Lower Deadwood Secondary System</u>	<u>Grizzly Gulch Lagoon System</u>
Capital Cost		
Collection System	\$1,585,000	\$3,149,000
Flow Reduction	109,000	109,000
Wastewater Treatment	2,630,000	\$ 4,226,000 - 5,704,000
Sludge Disposal	360,000	-
Total Construction Cost	4,684,000	7,484,000 - 8,962,000
Engr., Legal, Etc., (15%)	703,000	1,123,000 - 1,344,000
Total Project Cost	5,387,000	8,607,000 - 10,306,000
Federal Grant (75%)	4,040,000	6,455,000 - 7,730,000
State Grant (2.5%)	135,000	215,000 - 258,000
Local Cost	1,212,000	1,937,000 - 2,318,000
Operation and Maintenance Cost		
Collection System	23,000	55,000
Flow Reduction	5,000	5,000
Wastewater Treatment	162,000	87,000
Sludge Disposal	42,000	-
Total O&M Cost	232,000	147,000
Capital Recovery	114,000	183,000 - 219,000
Total Annual Cost	346,000	330,000 - 366,000
Estimated Monthly Household Cost	9.61	9.17 - 10.14
Present Worth	7,845,000	9,428,000 - 10,833,000

Table 7

COMPARATIVE EFFLUENT CHARACTERISTICS

<u>Parameter</u> (1)	<u>Lower Deadwood Secondary System</u>	<u>Grizzly Gulch Lagoon System</u>
BOD ₅		
Average	30	30
Maximum	45	45
Total Suspended Solids		
Average	30	30
Maximum	45	45
Fecal Coliform (MPN/100ml)		
30-day Average	200	200
Coliform (MPN/100ml)		
30-day Average	2,000	2,000
Total Residual Chlorine	0.05	0.05
Ammonia as N	3	3 to 5

(1) All units are in mg/l except as noted.

would not enter Whitewood Creek between Lead and Deadwood, as they would with the GGLS, this creek reach would be more aesthetically pleasing and more capable of supporting a fishery.

- The LDSS would be easier to implement than would the GGLS because of the above advantages.

Disadvantages

- Placement of a plant at lower Deadwood would preclude use of this industrially zoned land for other purposes, and it may present minor conflicts with surrounding land uses such as rodeo and fair events at the rodeo grounds.
- As a mechanical plant, the LDSS is dependent on proper management. Without competent plant operators, the plant could fail, resulting in poor quality effluent discharges and possibly local odors restricted to the immediate vicinity of the plant site. Odors would not be detectable from the rodeo grounds or highway.
- The plant would require more energy and chemicals for operation and maintenance. The LDSS would require 2.4 million kWh per year, compared to 1.8 million kWh per year for the GGLS. Also, the LDSS would require more chemicals for effluent disinfection and dechlorination.

GRIZZLY GULCH LAGOON SYSTEM

The GGLS involves the collection and transport of the District's wastewater to an aerated lagoon and winter storage reservoir in Grizzly Gulch, as shown on Figure 8. Effluent from the

system would be discharged into Grizzly Creek and would reach Whitewood Creek just above Pluma. Treatment of the District's wastewater would be provided by a 2- to 4-day detention time aerated lagoon located in a side branch of Grizzly Gulch and the 200-day detention time winter storage reservoir located on the main stem of Grizzly Gulch. Effluent disinfection and dechlorination facilities would be provided, although it is not anticipated that operation of these facilities would be needed to achieve the bacterial standards.

The GGLS is designed to be expanded and upgraded in a series of steps or phases. A storm collection system and holding pond located in Cub Gulch below Lead could be added at a later date. Capacity in the storage reservoir would be sized to handle the average yearly storm water runoff from the Lead area. Although this system would not be implemented immediately, space would be provided in the Pluma pump station for the addition of more pumping capacity. Another modification could be the addition of other unit processes, both upstream and downstream of the presently planned reservoir system. The dam would be located in such a manner as to provide enough head to lift the waste via an inverted syphon through Deadwood to the Mountain Meadow areas for possible future land treatment. Other land treatment sites above the City of Deadwood and possibly in the Grizzly Gulch vicinity could be utilized with a minimal amount of pumping.

Advantages

- The reservoir and dam components of this system have a longer design life (100 years) than does the LDSS (20 years).
- The system is relatively simple to operate and less subject to shock (toxic) loads than is the LDSS. It is also more amenable to the inclusion of storm water treatment.

- The GGLS requires less energy and chemicals for operation and maintenance, as discussed above.
- Located in Grizzly Gulch, this alternative would not commit relatively scarce industrially zoned land to sewage treatment as would the LDSS.

Disadvantages

- The cost of the GGLS is significantly higher than for the LDSS, as discussed above.
- The environmental impact of the GGLS would be significantly more severe with implementation of the GGLS than with the LDSS. Under the GGLS, 100 acres of forest would be destroyed and from two to 12 households would be relocated. By contrast, construction of the LDSS would disrupt about 4 acres.
- The GGLS would discharge to presently unpolluted reaches of Grizzly and Whitewood Creeks. This discharge would require a revision of the stream standards now based on a cold water permanent fishery objective in these reaches.
- The treatment ability of the deep storage reservoir is not well understood. Uncertainties and disagreement exist about the GGLS treatment capabilities.
- As a consequence of the previously listed disadvantages, the GGLS would be difficult to implement. It would require an extensive Environmental Impact Statement, and more than one Federal agency would be involved.
- Due to the depth of the lagoon, the effluent produced may have concentrations of dissolved nitrogen which are toxic to fish.

Section 6
DISCUSSION

Facilities planning is a dynamic process during which decisions are continually made as basic planning issues arise. As a result of the decisions made by the District in the past year, the numerous wastewater management alternatives developed during the facilities planning process have been modified and narrowed down to the two most feasible systems considered in the final competitive evaluation. Because these basic issues are so important to the planning process and the final selection of a management system, they are discussed below.

The issues discussed include the following:

- The question of whether achieving the effluent limitations in the District's NPDES Discharge Permit, issued in January 1975, would in fact allow Whitewood Creek to return to a permanent cold water fishery.
- The relative impacts that HMC's and the District's discharges have on regional and local water quality under the different treatment levels.
- Costs in perspective of returns gained.
- Capabilities of financing high level treatment systems.

ESTABLISHING A COLD WATER FISHERY IN WHITEWOOD CREEK

The effluent limitations presently contained in the Discharge Permit are based on (1) an assumed flow value for Whitewood Creek and (2) an assumed value for the background water quality. Data recently taken by the State indicate that the

water quality in Whitewood Creek above Gold Run, which receives the major discharges from Lead and HMC, does not meet several of the criteria established for the protection of a cold water fishery. Thus, the fishery objective may not be feasible under these conditions.

Another unknown factor affecting the establishment of a cold water fishery in Whitewood Creek is the impact of the existing tailings deposits in, and adjacent to, the stream. The regulatory agencies have assumed that in time Whitewood Creek would fully recover, given proper conditions, to support a cold water fishery. However, the amount of time necessary for the stream to purge itself of old tailings deposits has not been estimated. The potential of the old tailings deposits to prevent the establishment of a cold water fishery should be evaluated.

Due to these uncertainties, there is reasonable doubt that achieving the Discharge Permit effluent limitations would establish a cold water fishery. These uncertainties should be investigated before strict effluent limitations are imposed. To require the District to install an extremely costly and sophisticated treatment system to produce the effluent limitations and to later find that the assumptions on which these limitations were based were wrong would be unfortunate for all parties involved.

The DEP order of 5 March 1976 recognized the uncertainties associated with the establishment of a cold water fishery in lower Whitewood Creek. As stated previously, the order allows the District to provide secondary treatment with restriction on the levels of ammonia-nitrogen and total chlorine residual in Whitewood Creek. The order requires the District to meet the South Dakota Water Quality Standards by 1 July 1988 if in the future there is evidence Whitewood Creek will rehabilitate itself by that date. The order gives the

District until 1 July 1985 to petition for a rehearing for a continued waiver of the State standards. At the hearing, the District must provide evidence that the creek will not recover or be capable of supporting a cold water marginal fishery by 1 July 1988.

WATER QUALITY IMPACT OF WASTEWATER TREATMENT

The major improvement of regional and local water quality would be accomplished by the removal of HMC's waste discharges from the area streams. Treatment and control of the waste discharges from the District would have an important effect on the local water quality but would account for relatively little improvement of the regional water quality.

Impact on Regional Water Quality

As discussed previously, depressed water quality levels have been measured 110 miles below the industrial discharges by HMC in Gold Run. Depressed water quality is attributed to a combination of the high suspended solids material and toxic industrial wastes.

The regional water quality impact of controlling the waste discharges from the District and HMC is indicated on Figure 9. The total raw suspended solids estimated to be present in Whitewood Creek during low flows is represented by the first bar graph on the figure (based on recent data developed by the State). The pollution removal that would be accomplished under the Level 1 treatment (designed to achieve the Discharge Permit effluent limitations) is shown by the second bar graph. The concentration of suspended solids that is estimated to result from the Level 3 treatment is shown by the third bar graph. This figure demonstrates that the background levels exceed the suspended solids standard in the South Dakota Surface Water Quality Standards.

It is apparent from this figure that the overwhelming improvement in water quality (as measured by the suspended solids parameter) is due to the reduction associated with the treatment and control of HMC's waste discharges. The impact of treating the District's discharges is important, but not nearly as dramatic. Thus, the pollution reduction difference between Level 1 and Level 3 treatments for the District becomes minor relative to HMC's pollution abatement.

Impact on Local Water Quality

Ammonia-nitrogen is a critical constituent affecting local water quality and the ability to establish a cold water fishery. Figure 10 presents the raw wastewater ammonia-nitrogen loads estimated for Whitewood Creek during low flows. The first bar graph identifies the District's wastes as the major source of ammonia-nitrogen in Whitewood Creek. To meet the water quality objective, both the District and HMC must achieve Level 1 treatment, as indicated by the second bar graph.

No ammonia-nitrogen standard has been established for Level 3 treatment, although the system selected by the District would accomplish a limited amount of ammonia oxidation or removal. The maximum ammonia-nitrogen discharges that would be allowed for a cold water marginal fishery stream are shown by the third column. To achieve this objective, the District would have to reduce the ammonia-nitrogen level in their wastes to about 2.5 mg/l. This level of ammonia oxidation is possible with the treatment process of the Lower Deadwood Secondary System, although no assurance can be given that this level would be achieved on a year-round basis. Enclosing the treatment plant will minimize process variations during winter operations.

COST PERSPECTIVE

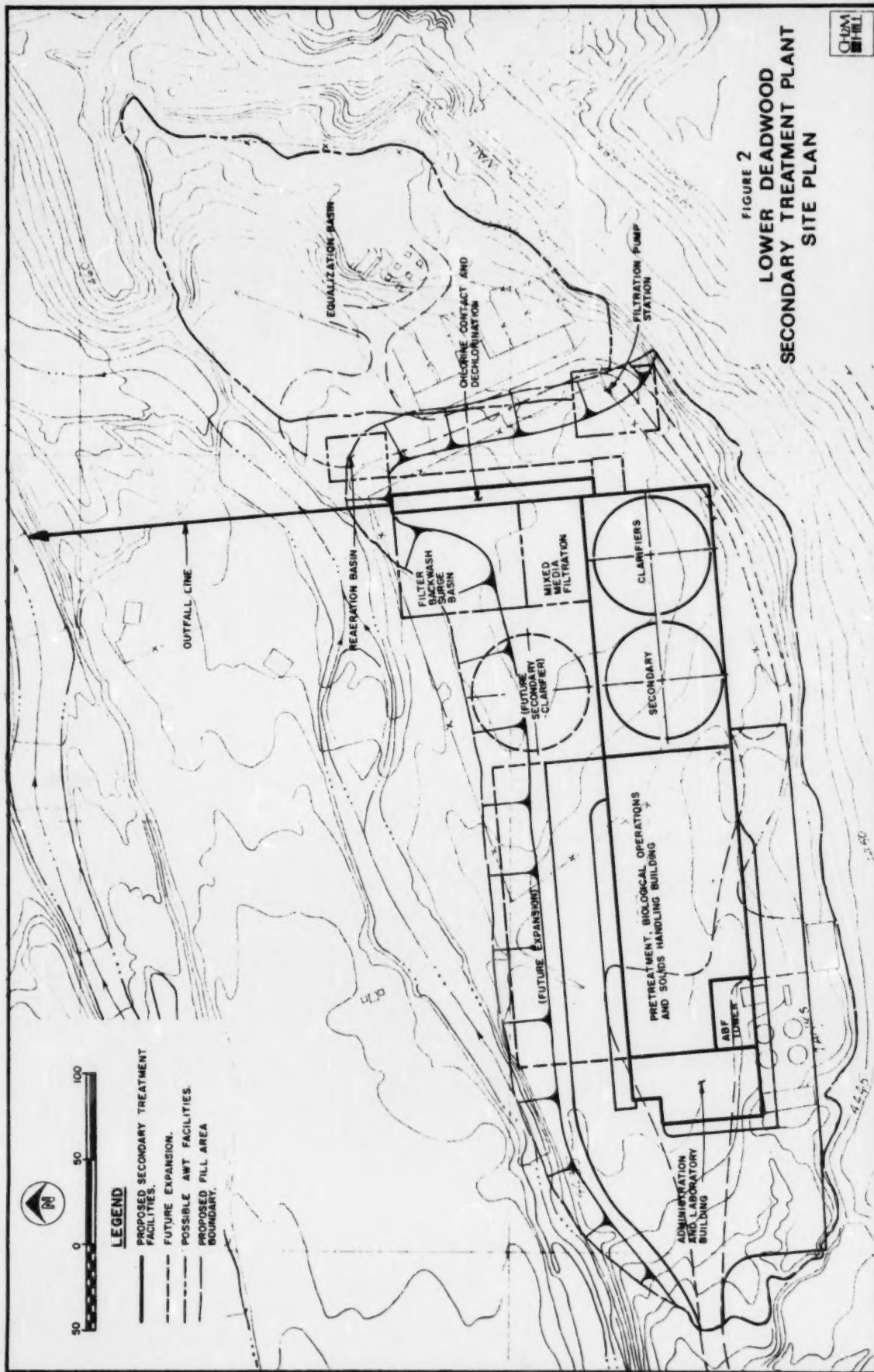
The costs of the alternatives must be put in the perspective of what returns would be gained from the investment. The household cost to the District to achieve the difference in treatment to possibly allow a cold water fishery is \$4 per month; the difference between \$14 per month for the high (Level 1) treatment system and \$10 per month for the lower (Level 3) treatment.

FINANCING CAPABILITIES

The treatment systems capable of producing an effluent which would satisfy the NPDES Discharge Permit and the South Dakota Surface Water Quality Standards are very expensive. Capabilities to finance a high level treatment system may be restricted by the following factors:

- Voter resistance to high monthly sewerage charges-- The monthly cost for the capital and operating expenses of the high treatment level systems is estimated at about \$14. The recent rejection of a \$4 per month charge for the collection and disposal of solid wastes indicates that voters may not accept a high service charge to clean up the area's wastewater discharges.
- Bonded indebtedness limitations--The ability of the District to go into debt could limit the size of the wastewater treatment project. Based on its assessed property valuation, the District's maximum allowable bonded indebtedness is \$2.6 million.





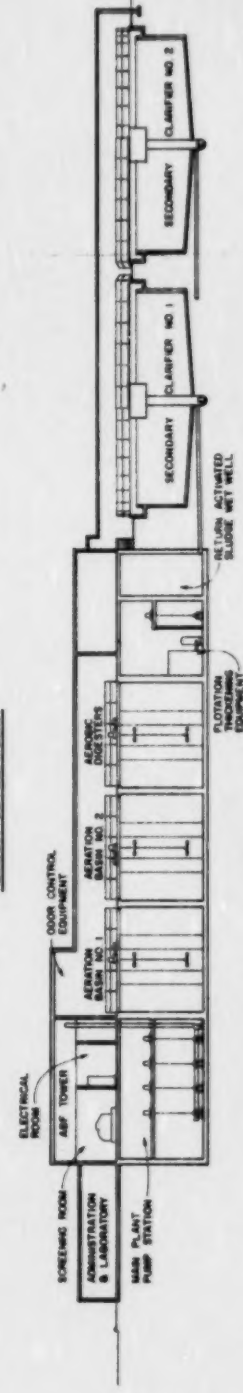
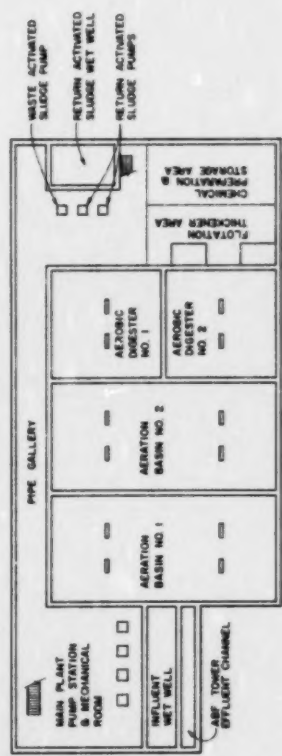
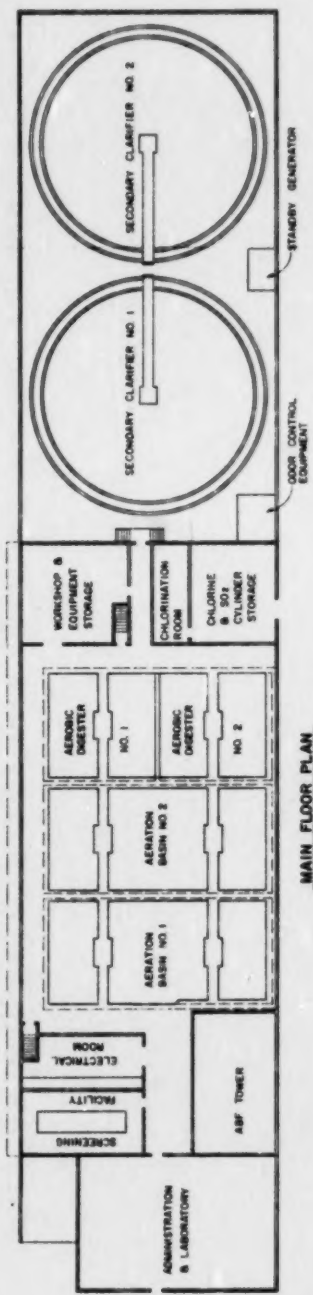
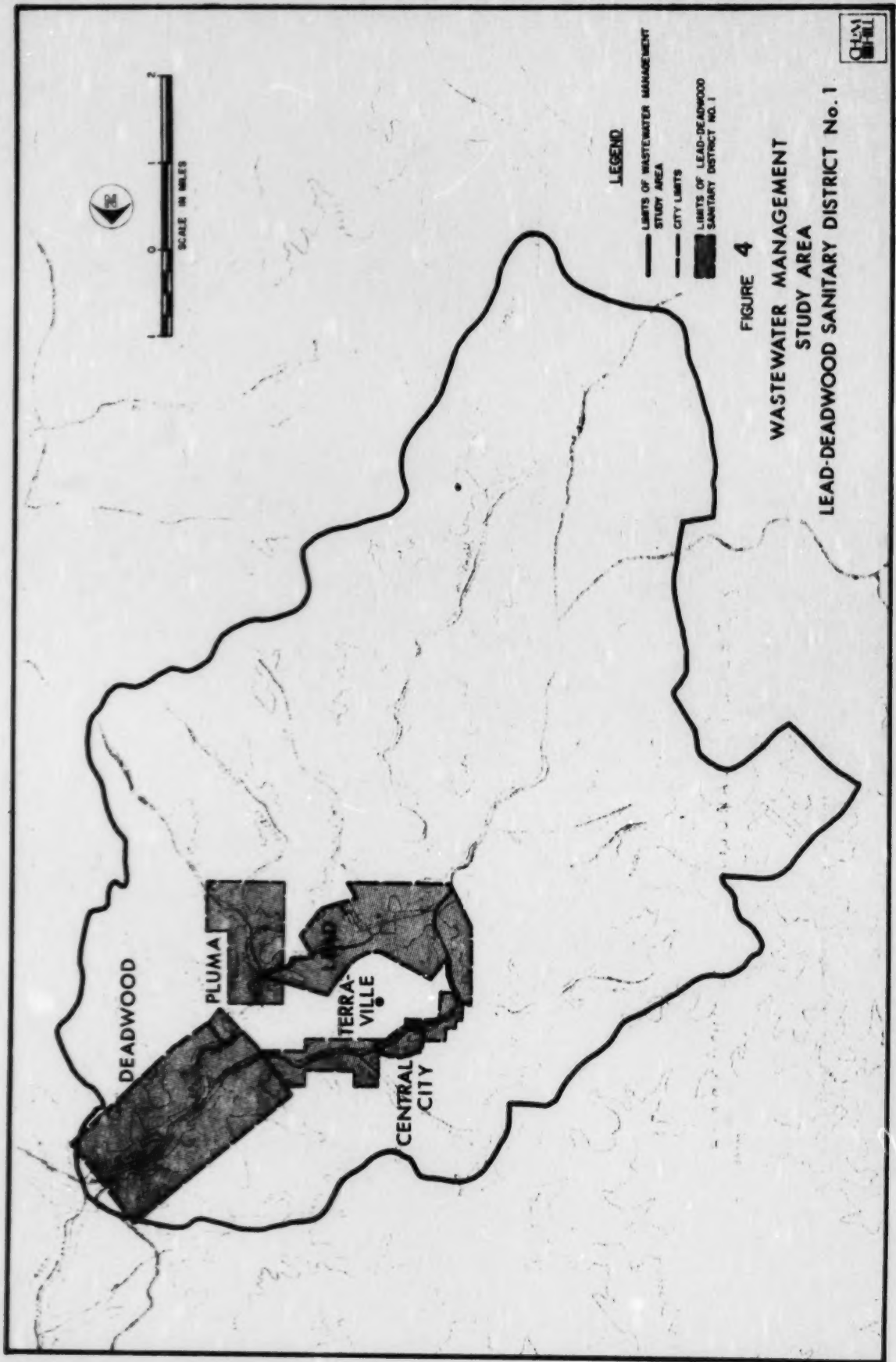


FIGURE 3
 LOWER DEADWOOD
 SECONDARY TREATMENT PLANT
 PRELIMINARY PLAN AND COMPOSITE SECTION





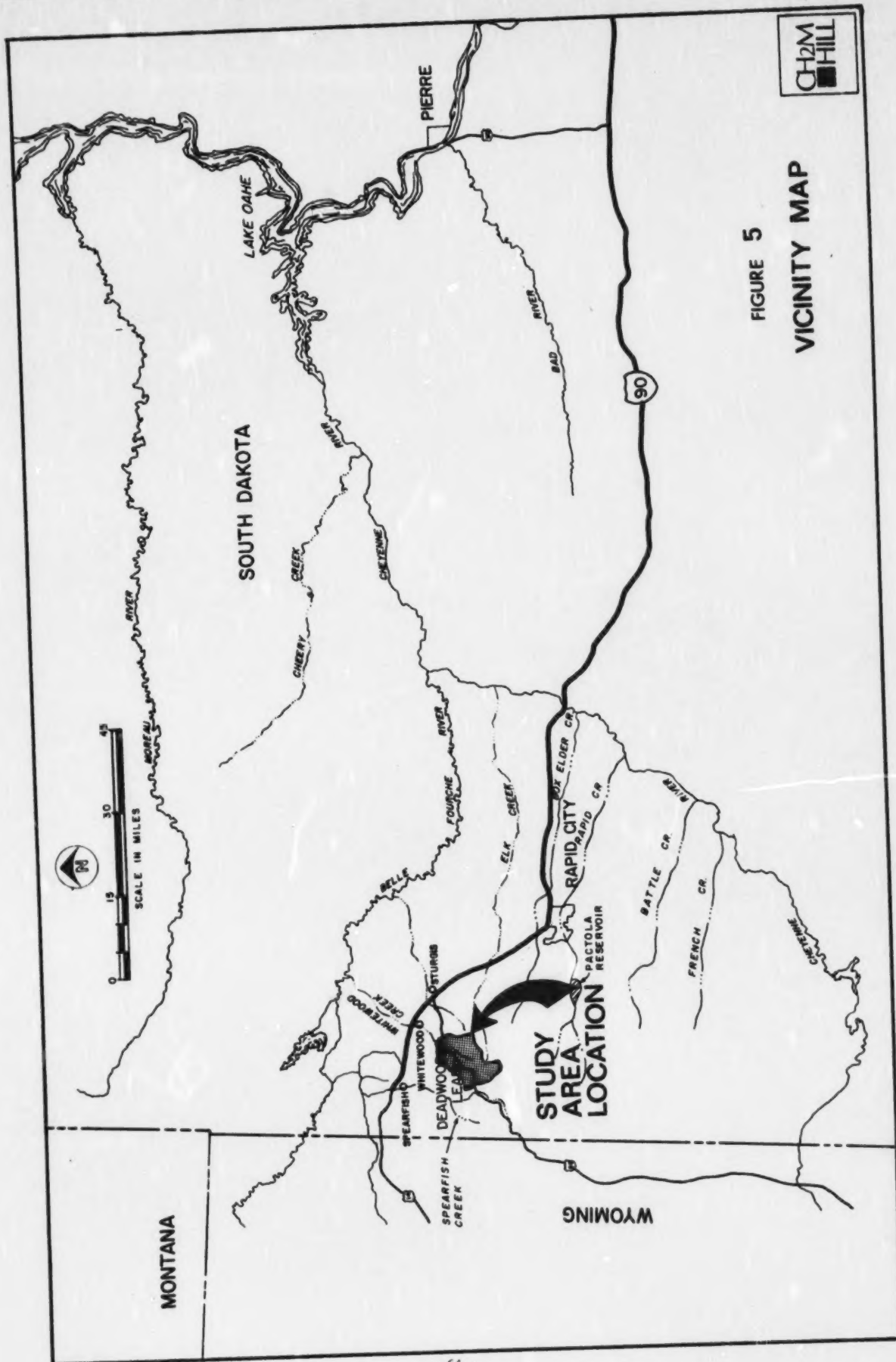
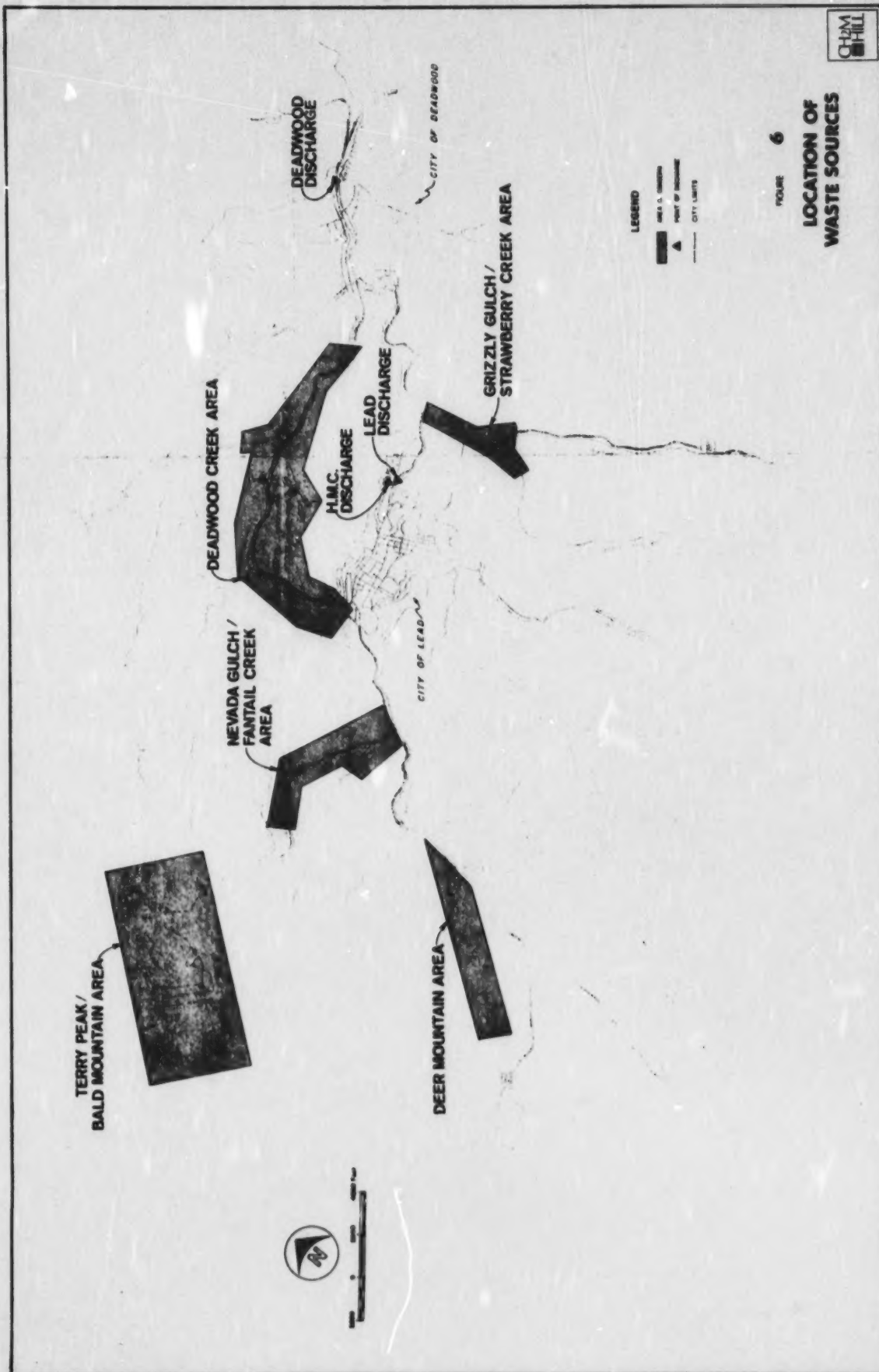
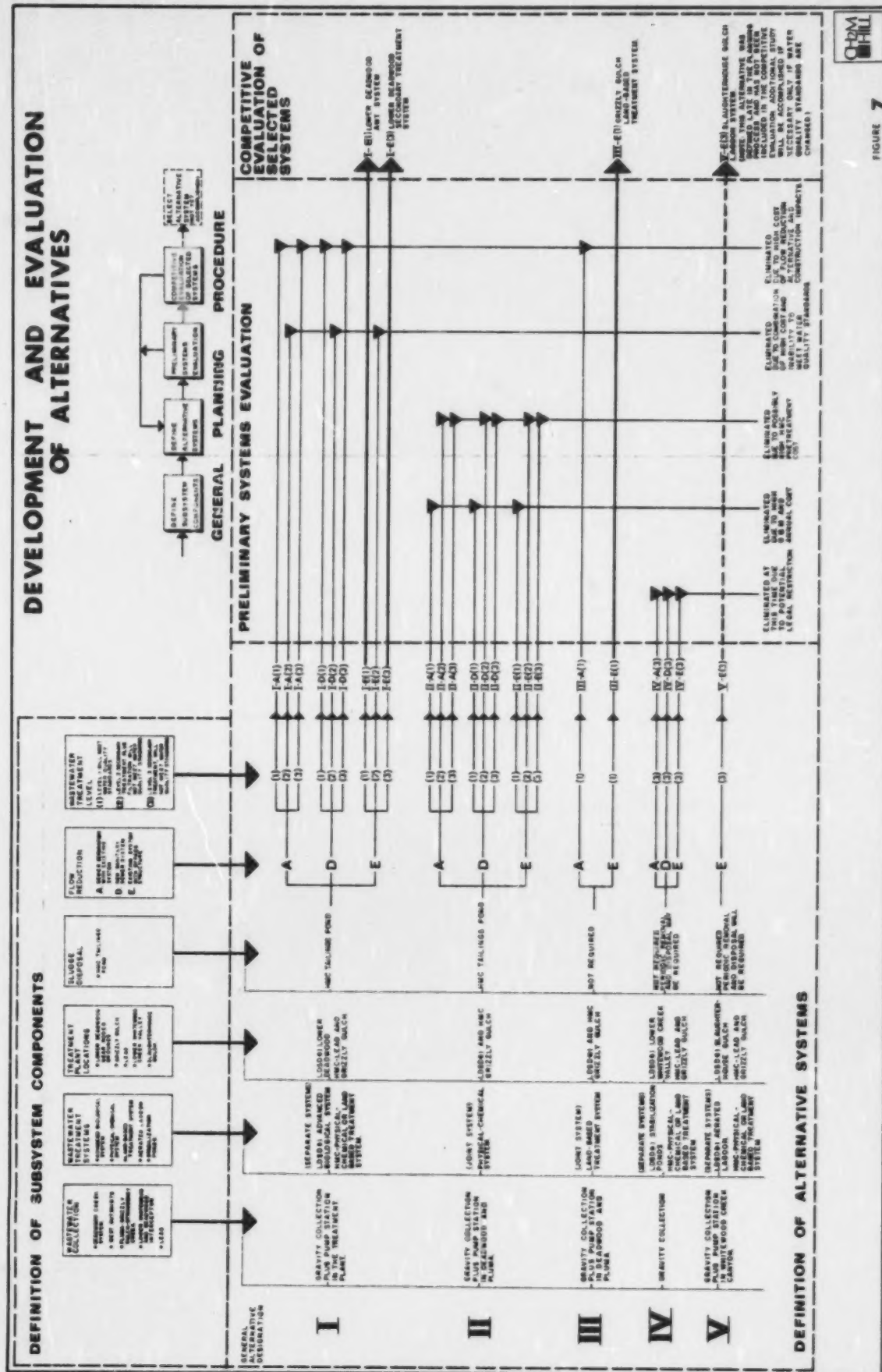


FIGURE 5
VICINITY MAP



DEVELOPMENT AND EVALUATION OF ALTERNATIVES



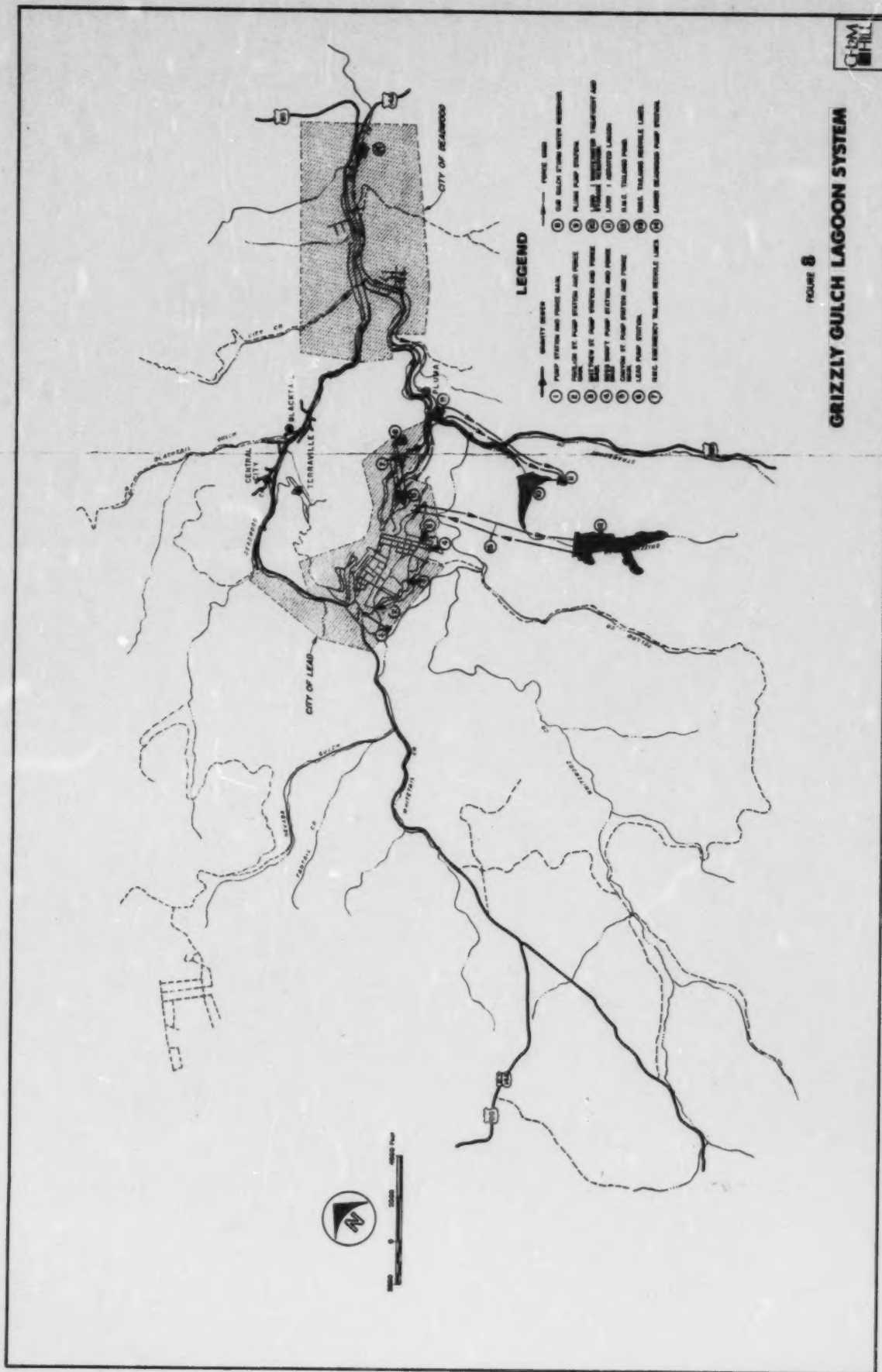
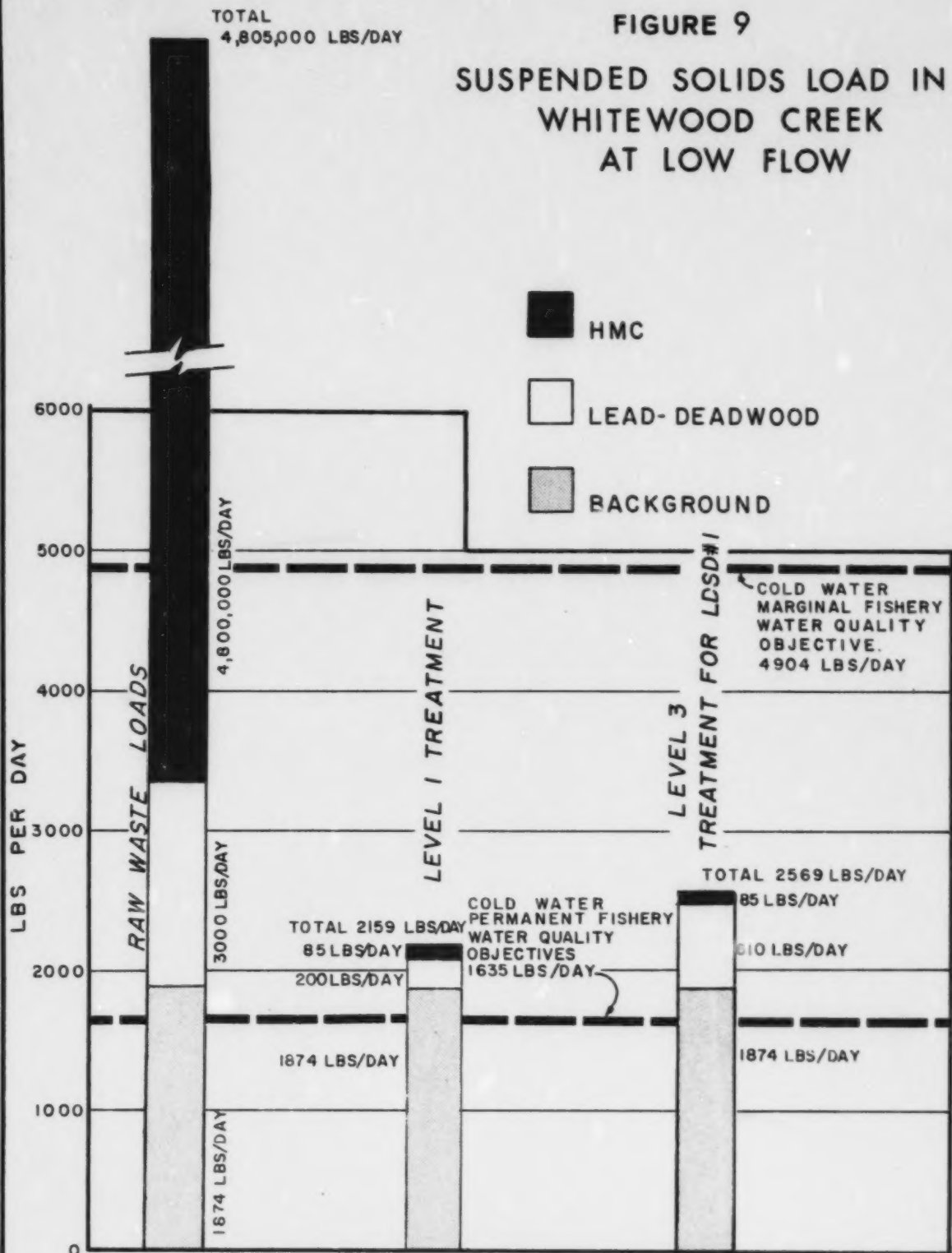


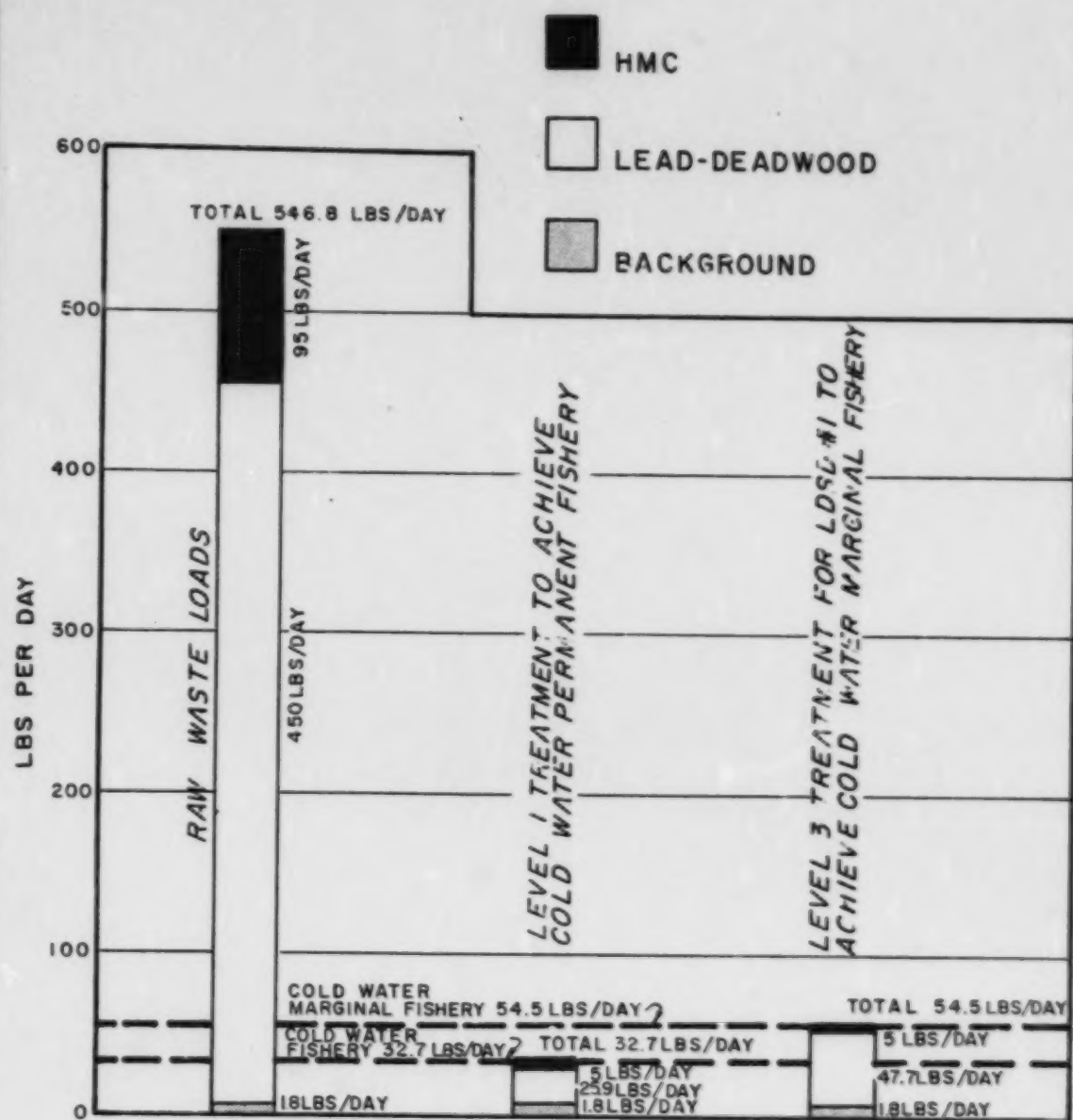
FIGURE 9

SUSPENDED SOLIDS LOAD IN WHITEWOOD CREEK AT LOW FLOW



NOTE:
SUSPENDED SOLIDS IN LBS/DAY
DISCHARGED TO WHITEWOOD CREEK





NOTE:
 $\text{NH}_3\text{-N}$ IN LBS/DAY DISCHARGE
 TO WHITEWOOD CREEK.

FIGURE 10
 AMMONIA-NITROGEN IN
 WHITEWOOD CREEK
 AT LOW FLOW



ENVIRONMENTAL ASSESSMENT

FACILITIES PLAN

LEAD-DEADWOOD SANITARY DISTRICT NO.1
DEADWOOD, SOUTH DAKOTA



FACILITIES PLAN
ENVIRONMENTAL ASSESSMENT
for
LEAD-DEADWOOD SANITARY DISTRICT NO. 1
DEADWOOD, SOUTH DAKOTA

Prepared by
CH2M HILL, INC.
12000 East 47th Avenue
Denver, Colorado 80239

RECEIVED

MAY 14 1976

OFFICE OF GRANTS
REGION VII

May 1976

D9103.03

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FACILITIES PLAN REPORT ORGANIZATION

This Facilities Plan study report consists of four documents:

- Administrative Report. The Administrative Report is a summary of the significant findings of the Facilities Plan and Environmental Assessment. It is a concise presentation of the selected wastewater management system, major background information, the most feasible wastewater management alternatives, and the basic issues surrounding those alternatives.
- Technical Report. The Technical Report contains supportive technical information for the Administrative Report and Environmental Assessment and documents the steps and decisions that evolved during the Facilities Plan study.
- Environmental Assessment. The assessment is an analysis of the environmental aspects of the proposed project, augmented by a discussion of the alternatives considered. This report is intended to supplement the Facilities Plan and to assist the U.S. Environmental Protection Agency's analysis of the ramifications of the project as required by the National Environmental Policy Act.
- Appendices. The Appendices contain detailed background material and copies of the various task reports developed during the facilities planning procedure. They document the basic data supporting the issues and conclusions discussed in the Administrative and Technical Reports. Copies of the Appendices are available for inspection at the Lead-Deadwood Sanitary District No. 1.

The complete Facilities Plan includes the revision of the draft Facilities Plan study report, documentation of public hearings, and a detailed description of the selected wastewater management alternative.

Throughout this report a distinction is made between the water quality objective, water quality standards or criteria, and effluent limitations. The water quality objective is the State's beneficial use designation of a cold water fishery for Whitewood Creek. The water quality criteria are the parameters determined by the State to achieve the water quality objective. The effluent limitations (based on the water quality criteria) are the discharge parameters specified in the National Pollution Discharge Elimination System (NPDES) Discharge Permits.

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SUMMARY

STUDY RESULTS

The Cities of Lead and Deadwood presently do not have adequate sewage collection or treatment. Discharges of untreated municipal and industrial wastewater have resulted in severe pollution of Whitewood Creek and some of its tributaries. Also, contamination of domestic wells has been documented in selected areas. In an effort to reduce public health hazards and to fulfill the EPA and State legislation requiring the development of a marginal cold water fishery in Whitewood Creek, the Lead-Deadwood Sanitary District (the District) has, with its consultants, investigated numerous wastewater management systems.

On the basis of the Facilities Plan study, the most viable system is to extend the District's sewerage service into selected outlying areas and to treat the collected municipal wastes in a secondary sewage treatment plant approximately 1/4 mile north of the Deadwood rodeo grounds in lower Deadwood. The 2.33-mgd plant will use an activated biological filter system for secondary treatment and nitrification (ammonia oxidation). Disinfection will be provided by chlorination, and sulfur dioxide will be used for dechlorination. The proposed project will service a population equivalent of 10,800 at a total annual cost of \$346,000. This represents an average household cost of about \$9.61 per month.

A synopsis of the benefits and unavoidable adverse environmental impacts associated with project construction and implementation is provided below.

Project Benefits

- Presently Whitewood Creek and portions of its tributaries function as open sewers. Because these streams pass through urban areas, exposure to viruses and pathogens presents a potential threat to public health. Likewise, pollution of ground water and contamination of domestic wells have been documented. Provision of the proposed collection and treatment systems will arrest these problems and therefore promote public health and welfare.
- The proposed project is a critical step in the rehabilitation of Whitewood Creek. Removal of raw sewage from the creek will help reestablish pollution intolerant wildlife and may allow the establishment of a marginal cold water fishery (put-and-take with no natural reproduction).

- Provision of a federally acceptable sewage system in Lead-Deadwood will qualify these communities for FHA and HUD loans. Improved housing in combination with the above-listed benefits will increase the desirability and economic value of real estate in Lead and Deadwood.

Unavoidable Adverse Impacts

- Installation of the interceptors and transmission line will have the following impacts:
 - Short-term erosion and possibly stream turbidity, especially in the upper reaches of Whitewood, Strawberry and Grizzly Creeks.
 - Temporary removal of vegetation along the pipeline corridor.
 - Disruption of traffic and local businesses, particularly where major interceptor construction passes through Deadwood and Pluma.
- Locating five pump stations in south Lead will have the following effects:
 - Hillside excavation, causing potential erosion and probable removal of several spruce for all five pump stations.
 - Modest visual change in the immediate area.
 - Minimum local odors possibly associated with pump stations.
- Impacts associated with the proposed lower Deadwood treatment plant are as follows:
 - Increased noise, dust, and vehicular emissions and congestion during construction.
 - A visual change during construction involving sight of machinery, exposed and stockpiled earth and construction supplies. This construction impact may not be considered adverse relative to the appearance of the wrecked cars now stored on the site.
 - Commitment of 4.0 acres of scarce industrially zoned land.

- Because the wastewater management system for Lead-Deadwood requires revamping the collection system and developing a new treatment plant, the cost to local citizens will be high -- estimated at \$9.61 per household per month. By contrast, sewage treatment costs have typically averaged from \$3.00 to \$5.00 per household. The high cost of the proposed system may prove burdensome to the elderly and other fixed income families.
- The Lead collection system combines sanitary and storm wastewaters. During high runoff periods, flows entering the sewer will not be completely accommodated by the proposed plant. Holding ponds were considered too expensive to construct at this stage of the facilities planning. Thus, combined wastewaters will be bypassed to Gold Run Creek during many storm events. The impact of this bypass on water quality cannot be determined at this time.

RECOMMENDATIONS

Most of the project's adverse environmental impacts are associated with the construction and are therefore short term. On the other hand, once the project is in operation, it will have the long-term benefits of protecting public health and improving the area's aquatic environment. Because the temporary adverse construction impacts are considered to be largely offset by the project's long-term benefits and because no significant environmental impacts have been identified, it is recommended that a Negative Declaration be issued by the U.S. Environmental Protection Agency.

Chapter 1 THE PROPOSED PROJECT

The Cities of Lead and Deadwood are presently without proper sewage collection and treatment, resulting in raw discharges of domestic sewage to Gold Run, Deadwood, Grizzly, City and Whitewood Creeks. The purpose of the proposed project is to provide the Lead-Deadwood area with a sewerage system to protect public health and clean up Whitewood Creek and its tributaries in compliance with State and Federal guidelines.

Implementation of this project is critical because Homestake Mining Company (HMC), the other major contributor to the area's water pollution problem, will complete their waste treatment program by July 1977. The industrial wastes discharged by HMC contain cyanide and other constituents that now mask the undesirable odors and visual impacts usually associated with raw sewage discharges. Once HMC wastes are removed from the stream, undesirable effects of raw domestic sewage will become pronounced, especially where the raw sewage flows through Pluma and Deadwood.

The water quality goal established by the State of South Dakota for Whitewood Creek is to achieve a cold water marginal fishery. The Lead-Deadwood Sanitary District No. 1 (the District) proposed sewerage system will collect and provide secondary treatment of the area's municipal wastes to eliminate the direct raw sewage discharges. It is not proposed to return Whitewood Creek to its natural water quality levels, because this would be prohibitively expensive for the District and HMC. Furthermore, the long history of mine waste discharges into Whitewood Creek may preclude development of a marginal cold water fishery. The rate of recovery of Whitewood Creek is subject to conjecture, and it may be several years or decades before the creek is usable as a fishery.

EXISTING CONDITIONS

Figure 1.1 defines the planning area considered by the District in the facilities planning procedure. The planning area can be generally described as the area lying tributary to Whitewood Creek immediately below Deadwood. The only part of the study area not in the Whitewood Creek basin is a new subdivision near the Terry Peak ski area that lies in the Spearfish Creek drainage basin.

The Lead-Deadwood area discharges into Whitewood Creek and its tributaries. This stream system has not only a local, but also a regional impact. Effects of the study area's pollution have been measured as far as 110 miles downstream, along the Belle Fourche and Cheyenne Rivers, shown on Figure 1.2.

The pollution sources within the Lead-Deadwood area are identified on Figure 1.3. The outlying areas of Deadwood Creek, Grizzly Gulch/Strawberry Creek, Nevada Gulch/Fantail Creek, Terry Peak/Bald Mountain and Deer Mountain represent minor sources of water pollution. These areas are presently unsewered with septage and untreated wastewater being discharged into the area's streams. Contamination of private water wells in the Nevada Gulch area has been documented by the county sanitarian. The area's three major pollution sources are the discharges from the Cities of Deadwood and Lead and from HMC.

Deadwood and Lead discharge both untreated storm water and untreated domestic wastewater into area streams. The City of Deadwood has separate storm sewer and domestic wastewater collection systems that discharge untreated wastewater at several points into Whitewood Creek. The major sanitary discharge point is located near the rodeo grounds in lower Deadwood. The City of Lead has a combined storm sewer and domestic wastewater collection system that discharges untreated wastewater into Gold Run. Gold Run discharges into Whitewood Creek in the vicinity of Pluma. Several small areas of Lead have Imhoff and septic tanks that discharge partially treated wastewater into area streams.

A third major pollution source in the Lead-Deadwood area is the discharge of tailings and industrial waste from HMC. HMC's waste is the area's largest suspended solids, cyanide, and heavy metals pollution source. At present, HMC discharges approximately 2,700 tons to 3,000 tons per day of tailings. These tailings, along with process water, are discharged into either the lower reaches of the Lead combined collection system or Gold Run Creek. HMC's tailings, combined with those of other previously operating mills, have created an estimated 199 acres of deposits along Whitewood Creek and 2,456 acres of deposits along the Belle Fourche River.

PROPOSED PROJECT

The proposed project will extend the sewage collection system with transmission to a 2.33-mgd biological treatment plant to be built in lower Deadwood, 1/4 mile north of the rodeo grounds. The project has a 20-year design life and a present worth of \$7.8 million. It has been sized for a 10,800 population. The project service area, collection system and treatment plant location are shown on Figure 1.4. A detailed discussion of the technical aspects of the project is presented below. The major project components that are of importance to this environmental assessment are the new interceptors and transmission lines, five pump stations, treatment plant, and borrow area for importing fill material. This report evaluates the potential impact on the entire study area environment as well as the immediate project facility locations.

COLLECTION SYSTEM

The proposed wastewater collection system will serve Lead, Deadwood, and several surrounding areas presently in the District. Approximately 48,000 feet of new interceptor will be built, and a new 1,600-foot transmission line will be installed from lower Lead to the lower Deadwood plant site. The outlying areas of Deer Mountain, Terraville, Terry Peak/Bald Mountain, and Nevada Gulch/Fantail are not included because of the high cost associated with serving the relatively small number of homes in these areas.

Outlying areas included in the proposed collection system are combined into three groups. The Deadwood Creek system will provide service to existing homes in the Deadwood Creek drainage basin, including Central City, Blacktail, and Glendale. The south Lead system will consist of five small pump stations, identified on Figure 1.4, to discharge the south Lead flows into the existing Lead collection system. The third major group consists of the Pluma, Strawberry Creek and Grizzly Gulch collection systems. The proposed collection system is shown on Figure 1.4.

The interceptor sewer additions to the wastewater collection system will be gravity sewers of either vitrified clay or concrete pipe. Standard construction methods will be used for trench excavation, pipe installation, backfilling and repaving when necessary.

LOWER DEADWOOD SECONDARY TREATMENT PLANT

The District's wastewaters will be treated in a secondary treatment plant near the rodeo grounds in lower Deadwood. The treatment plant site plan is shown on Figure 1.5, and the layout of the unit processes is presented on Figure 1.6. The proposed treatment facility will be entirely enclosed within a building to lessen the visual and odor impacts. The treatment facility features are described below.

Raw Sewage Pump Station

A raw sewage pump station with a capacity of 7.0 mgd will lift the wastewater from the gravity interceptor to the pretreatment system. The pump station may be located near the rodeo grounds bridge. It will contain its own standby power system to prevent bypassing flows during power outages.

Rotary Screens

Rotary screens will collect and remove large solids from the raw wastewater. The effluent will flow by gravity to the main plant pump station. The screened solids will be conveyed to a waiting dump truck for disposal in a sanitary landfill.

Main Plant Pump Station

The main plant pump station will blend the pretreated effluent with return flows from the fixed film biological reactors, supernatant from the aerobic digesters, and sludge recycled from the secondary clarifiers. Pumping capacity will be about 7.8 mgd. This pump station will lift the flow to the top of the activated biological filters.

Activated Biological Filter System

The activated biological filter system (ABF) is a combination of the trickling filter and activated sludge processes. During this secondary treatment, organic material and ammonia will be oxidized and the organic matter will be consumed by bacteria. Wastewater will be distributed over the top of the filter media by a fixed nozzle distribution system. A portion of the underflow will be recycled, along with the settled sludge from the secondary clarifiers, to the main plant pump station. Effluent from the filter tower will flow by gravity into two aeration basins, where the organic matter will be further broken down by bacteria. Design criteria for the ABF system are listed on Table 1.1.

Air moves through the towers by natural air convection currents. Unless the towers are severely overloaded, this air movement is sufficient to avoid any potential odor problems. However, fans will be provided to increase the amount of air moving through the towers. The exhaust air will be scrubbed to further control odors. A permanganate or ozone scrubbing system will be used.

Blowers located in the main plant pump station will supply air for the aeration system in the aeration basins and aerobic digesters.

Secondary Clarifiers

Suspended solid material will be removed by gravity in two circular clarifiers. To prevent sludge denitrification and its resulting floating sludge, rapid sludge removal mechanisms are to be employed.

Scum and grease will be removed from the surface of the secondary clarifiers with double scum skimmer arms. To remove the scum from the treatment process, scum pumps will deliver the scum from a common collection pit to either the aerobic digesters or a hopper for direct disposal in a sanitary landfill. Facilities will be included to dewater the clarifiers, aeration basins, aerobic digesters, and air flotation thickener units.

Table 1.1

ACTIVATED BIOLOGICAL FILTER
SYSTEM DESIGN CRITERIA

Filter Towers

Number of Towers	1
Average BOD Load	1,920 lbs BOD/day
Average Volumetric BOD Loading	145 lbs/1,000 ft ³ /day

Aeration Basins

Number of Basins	2
Total Liquid Volume	0.60 million gallons
Detention Time	
Average Daily Flow of 2.33 mgd	6.2 hrs.
Maximum Daily Flow of 3.0 mgd	4.8 hrs.
Average Waste Sludge Production (Dry Solids)	1,000 lbs/day
Average Sludge Recycle Rate	50%

Disinfection and Dechlorination Systems

For disinfection, 5 to 8 mg/l of chlorine will be added to the secondary clarifier effluent before it is discharged into a 1-hour detention time contact basin. Plant water will be withdrawn from this basin. It can be used for chlorine injection, pump seals, irrigation, scum spray control, cooling, washdown, and other miscellaneous plant uses.

Sulfur dioxide will be used for dechlorination. The effluent pH will be monitored and adjusted with sodium hydroxide. Both of these chemicals will be applied in the effluent end of the contact basin.

A small blower station will provide air for reaeration of the chlorine contact chamber effluent in the effluent pipe.

Aerobic Sludge Digestion

Waste sludge from the secondary clarifiers will be pumped to two parallel aerobic digester basins. The design criteria for the digesters are presented on Table 1.2. Based on a 1-percent underflow solids concentration from the clarifiers, the aerobic digesters will have a 20-day detention time. The aerobic digesters will allow supernatant to be decanted from the solids, thereby increasing the solids content and sludge detention time.

Table 1.2

AEROBIC DIGESTERS DESIGN CRITERIA

Number	2
Volume	18,900 ft ³
Detention Time	20 days
Solids Under Aeration	1%

Sludge Thickening

To decrease the volume of sludge that must be disposed of in a nearby sanitary landfill, an air flotation thickening system will be used with the design criteria shown on Table 1.3. The sludge should be thickened from the 1 percent found in the aerobic digesters to 4 or 5 percent dry solids in the float cake.

To assist in the dewatering of the sludge, facilities for storing, mixing, and adding polyelectrolytes will be provided. A total of 4 to 5 pounds per day or 0.8 tons per year will be required.

Table 1.3

AIR FLOTATION THICKENER DESIGN CRITERIA

Number (1 standby)	2
Area	60 ft ²
Dimensions	10 ft x 6 ft x 10 ft
Solids Loading	2.0 lbs dry solids/ft ² /hr
Polyelectrolytes Added	10 lbs/ton dry solids
Effluent Recycle Rate	100%

Administration and Laboratory Area

An administration and laboratory area will house a laboratory with automatic sewage sampling equipment, sample storage, office space, lockers and restrooms, maintenance equipment, a storage area, plant instrumentation and monitoring equipment. A workshop and storage area will also be provided as part of the facility.

Electrical System

Electrical power for the treatment plant can be obtained from Black Hills Power and Light, who serves the site. Points of service will be established near the raw sewage pump station. Standby generation equipment of sufficient capacity to maintain the operation of the entire plant during power outages will be provided.

Odor Control System

Odor control equipment will be provided to ensure that no undesirable odors from the treatment processes reach the community. Odor control will be provided by either a permanganate or ozone scrubbing system.

LAND REQUIREMENTS

The sewer system construction will generally take place adjacent to existing roadways. However, in sections of the Cities of Lead and Deadwood and through narrow canyon areas, interceptors will be placed under the roadways. Sewer and construction easements must be obtained to install the new collection system. Permits from the Highway Department will be required for any crossings of highway or construction in highway rights-of-way. The sewer easements will typically be 10 to 50 feet wide with 20- to 100-foot wide construction easements. Individual easement widths will vary according to the location of the sewer and the topography of the land. It is anticipated that sewer construction will occasionally require rock excavation that will necessitate the offsite disposal of the rock and the importing of suitable backfill material.

A total of 4 acres will be required for the lower Deadwood secondary system. The proposed wastewater treatment plant at lower Deadwood will require a 2.5-acre site. An additional 1.5 acres will be provided for possible future addition of advanced wastewater treatment facilities or expansion of plant capacity. Approximately 18,000 cubic yards of fill material must be imported to the treatment plant site to ensure adequate flood protection. Access to the plant will be by existing roads that will not require any improvements.

CONSTRUCTION SCHEDULING

Construction of the wastewater treatment plant and the collection system can proceed concurrently. The entire project will require approximately 2 years for construction.

Sewer construction will require close coordination between the contractor and local traffic officials in order to minimize the inconveniences caused by road closures. The construction will proceed rapidly during good weather and slow down or stop completely during severe winter conditions.

Treatment plant construction will proceed with only minor disruption of the normal activities in the City of Deadwood. The contractor will lease a site adjacent to the plant site from which his operations will be based. This site could either be the State land located west of the construction site or private land to the northeast. Excavation, concrete work and backfilling will proceed during good weather while equipment installation and finish work within the main treatment plant building can be done during winter months.

OPERATION AND MAINTENANCE

The District will require an additional staff member besides the present manager to handle the accounting responsibilities of the District. Also, the lower Deadwood wastewater treatment plant will require substantial supervision by properly trained plant personnel. Five or six full time employees will be needed to adequately staff the facility. If operated and maintained conscientiously, the plant will consistently produce the desired effluent quality.

The biological processes utilized at the facility require frequent monitoring and control. Laboratory analysis, an understanding of the biological processes involved and operator experience are necessary for proper operation of the biological system. Proper mechanical condition of the plant's equipment must also be maintained for reliable operations. A preventive maintenance program along with the ability to do most mechanical repairs is necessary. One plant mechanic will also be responsible for daily checking the small pump stations that serve

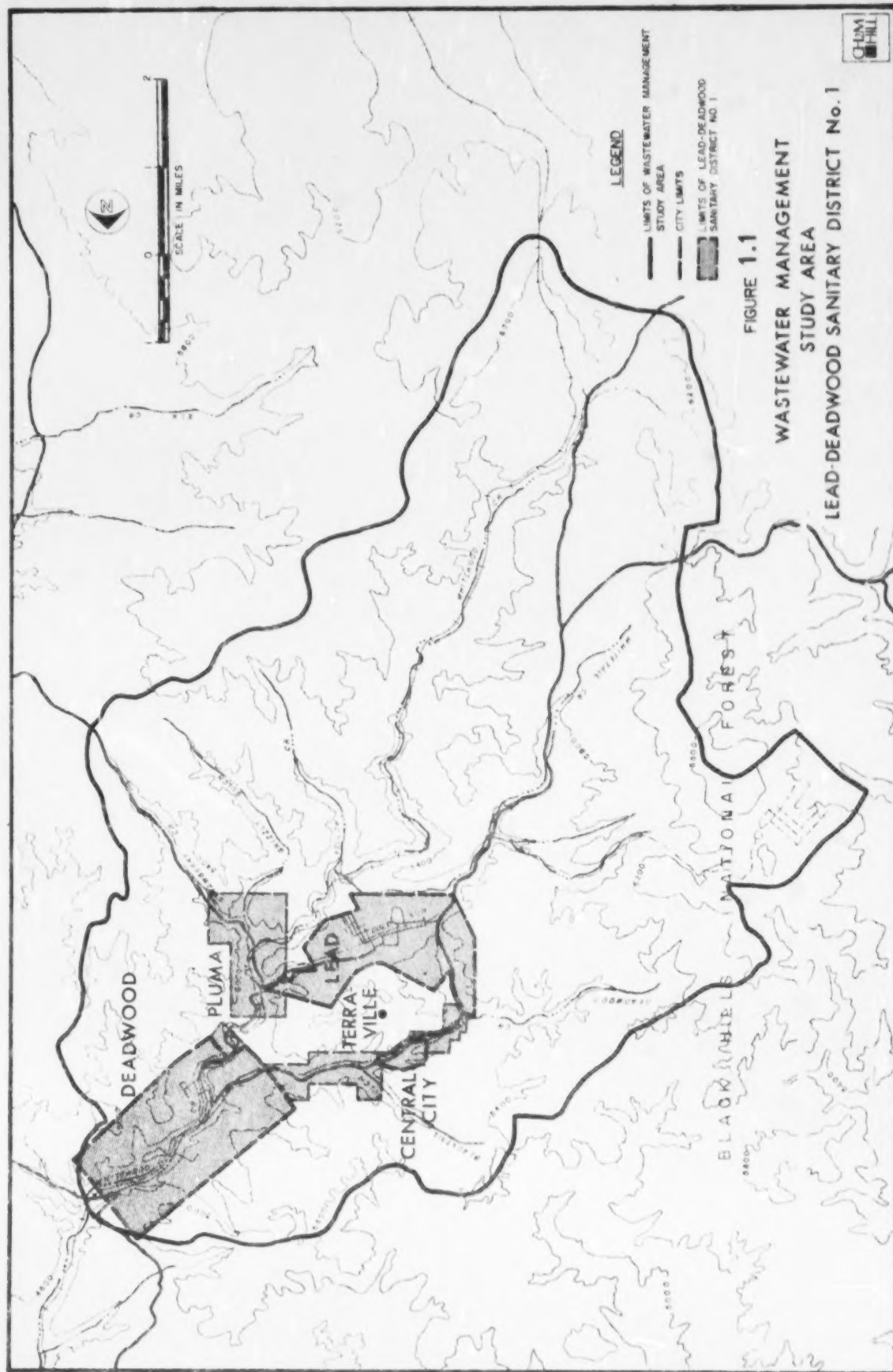
the Lead collection system. This mechanic or the Public Works Department could also fix minor sewer blockages, while major repair work can be done by a local contractor.

Housing the biological processes inside a building will also increase plant reliability because of the decreased process exposure to severe winter weather conditions.

Operation of the treatment plant will require approximately 2.4 million kWh per year. Plant operations will also require the importing of several chemicals. Approximately 28 tons per year of chlorine will be used for effluent disinfection and 8 tons per year of sulfur dioxide will be used for dechlorination. Relatively small amounts of polymer for flotation thickening and permanganate or ozone for odor control will also be required.

FUTURE PLANS

Future plans for the District will depend on the ability of Whitewood Creek to recover from 95 years of abuse, as well as any changes in the social and economic conditions of the area. If there is future evidence that the creek will rehabilitate itself by 1 July 1988 the State of South Dakota will require more stringent effluent limitations. Equally important, if the Lead-Deadwood area experiences unprojected growth, the treatment system will require expansion. The proposed treatment system has been designed so that adequate space is available for future additions.



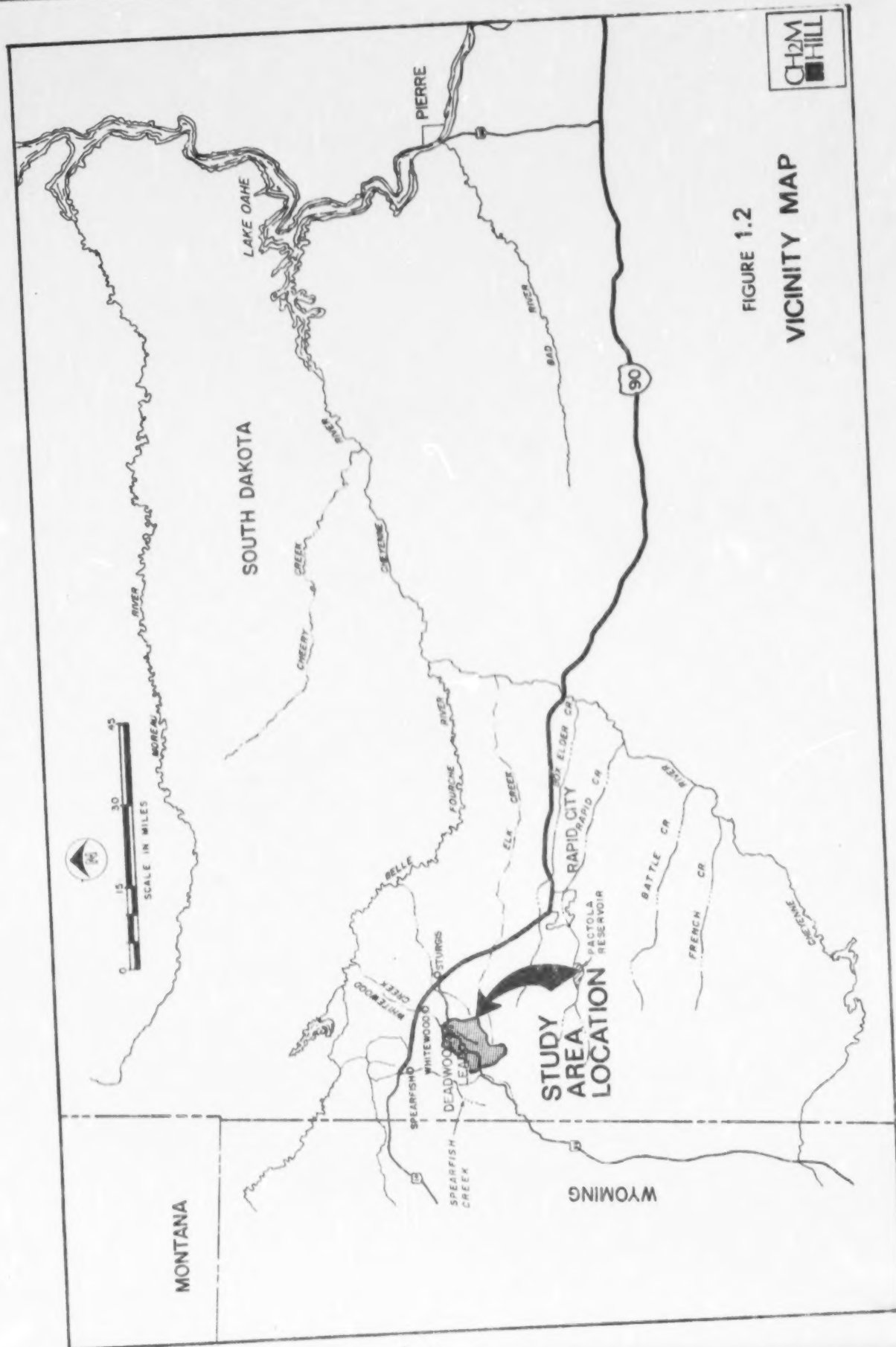
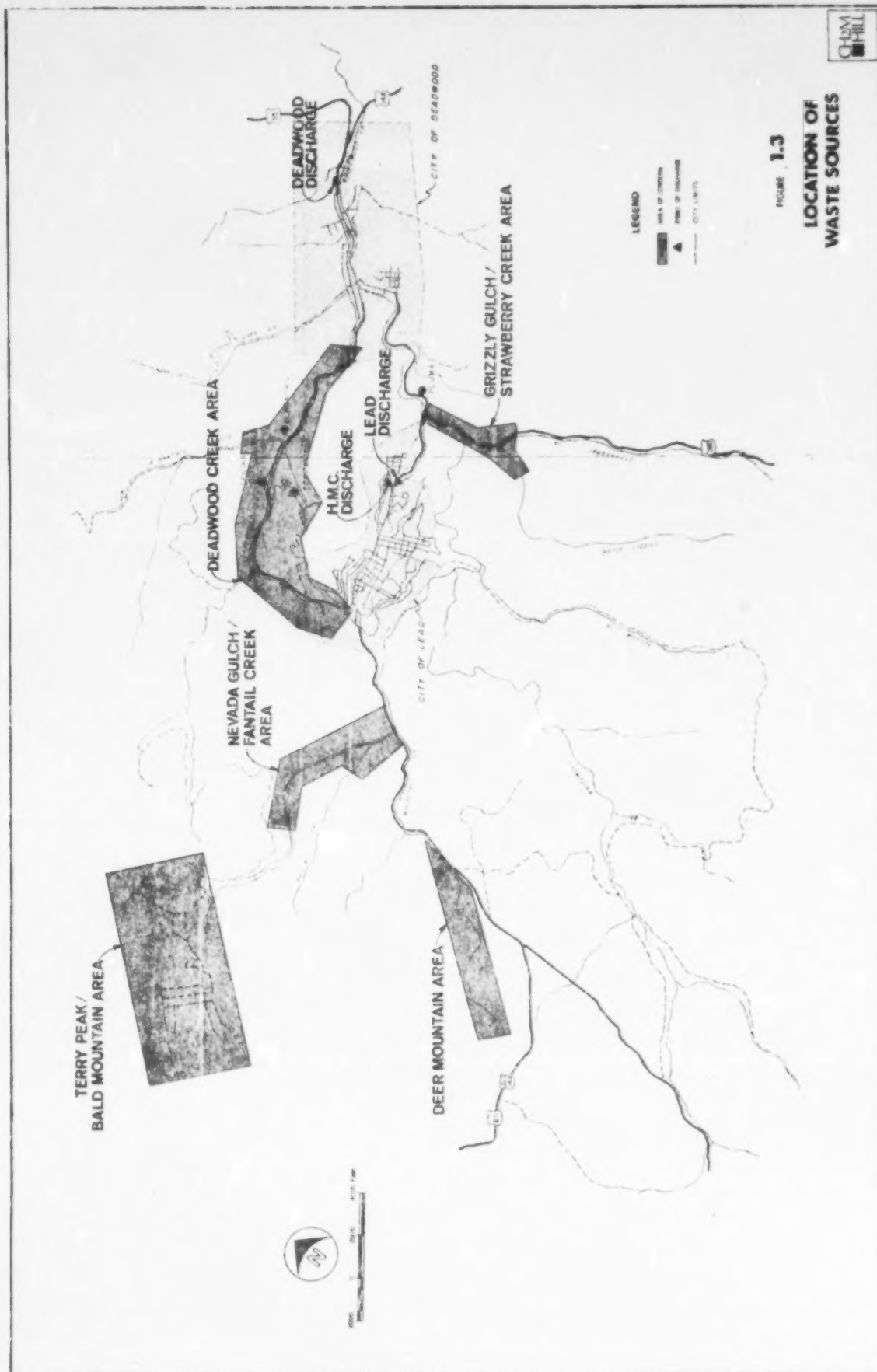


FIGURE 1.2
VICINITY MAP



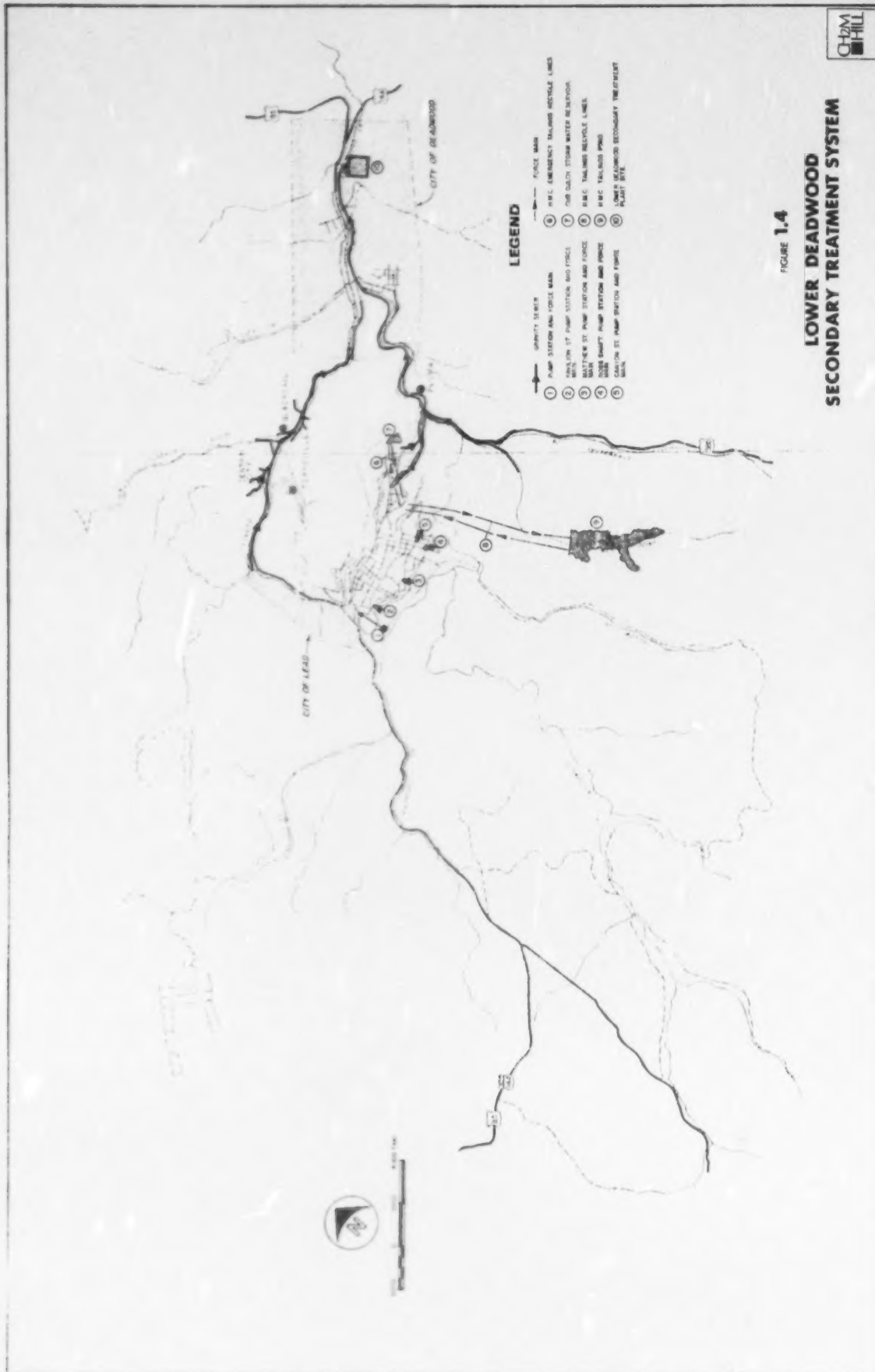
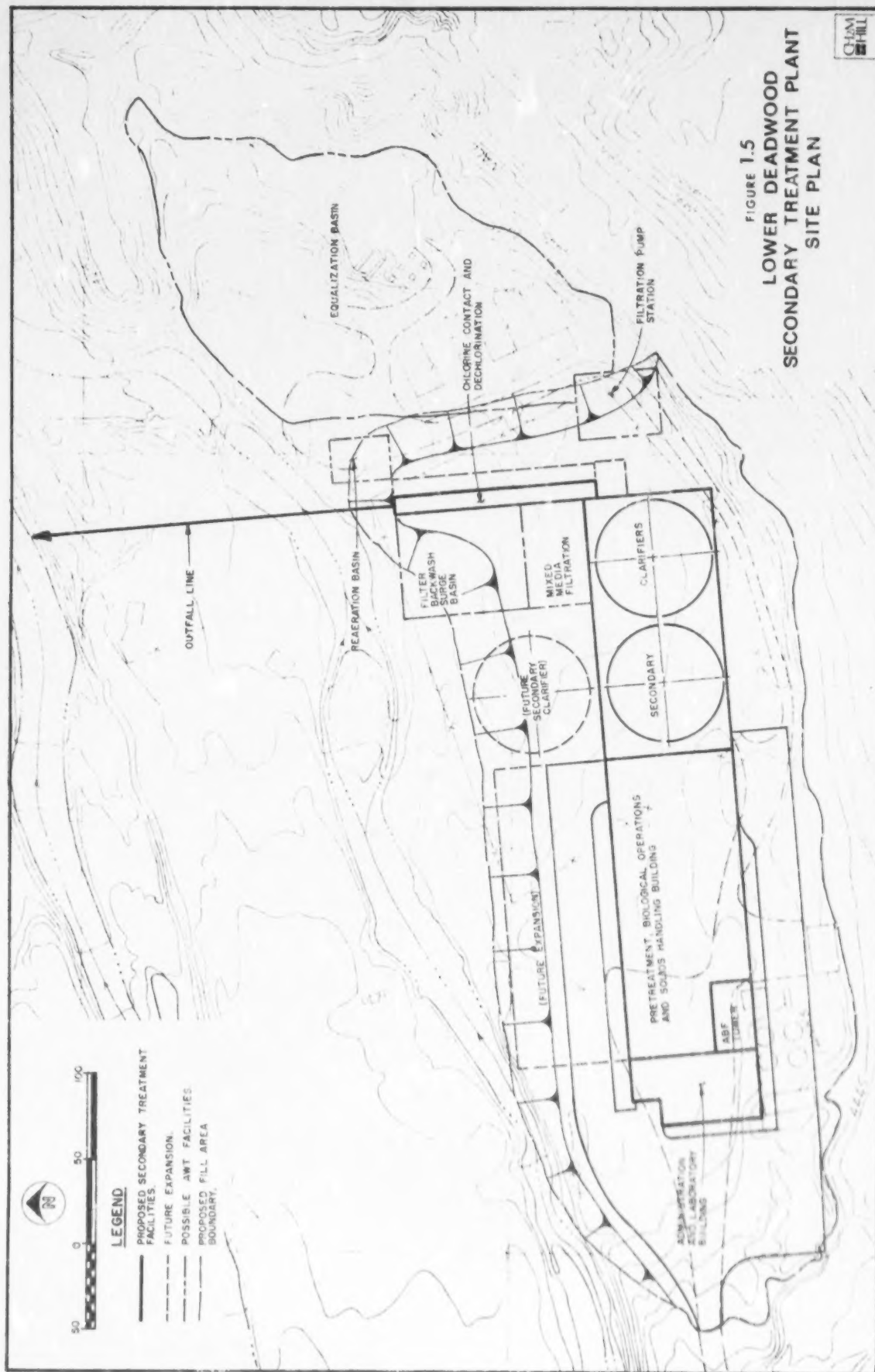


FIGURE 1.4
**LOWER DEADWOOD
 SECONDARY TREATMENT SYSTEM**





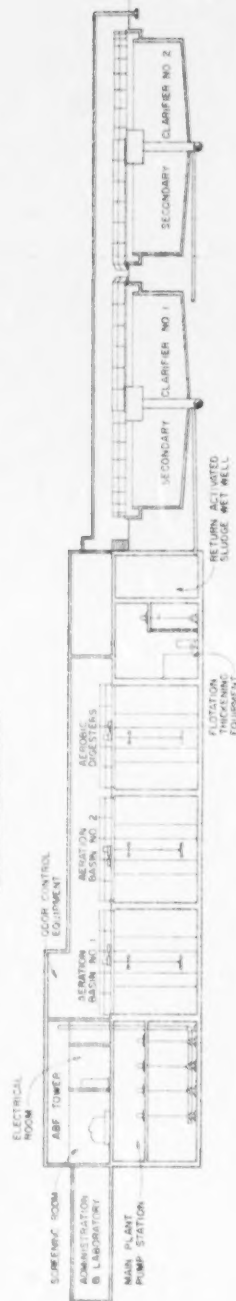
0 10 20 30 40 50
SCALE IN FEET



MAIN FLOOR PLAN



LOWER LEVEL PLAN



COMPOSITE SECTION

FIGURE 1.6
LOWER DEADWOOD
SECONDARY TREATMENT PLANT
PRELIMINARY PLAN AND COMPOSITE SECTION



Chapter 2 DESCRIPTION OF EXISTING ENVIRONMENT

Considerable environmental and ecological information has been collected in the Lead-Deadwood area during the District's efforts to develop a wastewater treatment facilities plan. This information has been thoroughly reviewed for this environmental assessment. Much of this information is contained in the following three environmental reports:

- Lead-Deadwood Sanitary District No. 1. March 20, 1974. Environmental Assessment.
- Environmental Protection Agency, Region VIII. March 1972. Final Environmental Statement. Lead-Deadwood Sanitary District No. 1, Project No. WPC SD-200.
- CH2M Hill, Denver, Colorado. February 1975. Basinwide Environmental Overview. Prepared for Lead-Deadwood Sanitary District No. 1.

These reports are the major sources for the following description of the Lead-Deadwood study area environment.

CLIMATE

The Lead-Deadwood area modified continental climate is influenced by the steeply rising Black Hills and the surrounding prairies. In general, the area has warm summers, cold winters, moderate precipitation, low relative humidity, and rapid evaporation. Characteristically of mountain regions, rainfall increases and absolute humidity decreases at higher elevations. The detailed climatological information given below is a summary of Chapter 4, "Climatology," in Basinwide Environmental Overview.

Rainfall, snowfall, and rainfall frequency data are presented on Tables 2.1, 2.2, and 2.3, respectively. Since 1954, rainfall in the area has averaged around 30 inches annually, ranging from a low of 12.87 inches in Lead to a high of 48.42 inches in Deadwood. Snowfall averages 113 inches per year and usually occurs during 10 months out of the year. The range of snowfall is 223 inches to 43 inches. The greatest amount of precipitation occurs in the months of March through July. Rainfall can be expected to exceed 1 inch per hour an average of once a year, while 2 inches or more occur an average of once in 10 years.

Temperature averages 55-56°F as a daily maximum and 30-33°F as a daily minimum. High temperatures in the 90's and lows in the 20's are not uncommon. No wind or evaporation data exist specifically for the Lead-Deadwood area. The U.S. Weather

Table 2.1
AVERAGE MONTHLY AND ANNUAL PRECIPITATION IN
LEAD AND DEADWOOD
(In inches)

<u>Month</u>	<u>Lead⁽¹⁾</u>	<u>Deadwood⁽²⁾</u>
January	1.15	0.79
February	1.15	0.87
March	1.91	2.26
April	3.21	4.83
May	4.29	5.04
June	4.03	3.80
July	2.60	2.57
August	2.00	1.61
September	1.86	2.12
October	1.55	1.86
November	1.30	1.25
December	1.17	1.69
Annual	26.26	28.69

- (1) Based on 60 years of record (1905-1973).
 (2) Based on 40 years of record (1909-1923, 1943-1949, 1954-1973).

Table 2.2
AVERAGE SNOWFALL DEPTH IN LEAD⁽¹⁾
(In inches)

September	1.3
October	7.3
November	12.7
December	14.2
January	14.2
February	14.6
March	21.1
April	20.8
May	6.3
June	0.7
Annual	113.2

- (1) From 1910-11 through 1973-74. This table varies from the data found in the CH2M HILL Grizzly Gulch Supportive Data report, December 1974, because it includes the period from 1969-1974.

Table 2.3
24-HOUR RAINFALL FREQUENCY DATA
FOR LEAD⁽¹⁾
(In inches)

<u>Frequency of Occurrence</u>	<u>Total Rainfall</u>
2 years	2.5
5 years	3.1
10 years	3.7
25 years	4.3
50 years	4.85
100 years	5.3

- (1) From regional maps compiled by Soil Conservation Service.

Service estimates that the prevailing winds in the area blow year round from the northwest. Evaporation rates can be estimated from records kept at Pactola Dam about 30 miles south-southeast of the study area and at about the elevation of Deadwood. Based on pan evaporation measurements at Pactola, the annual evaporation rate is estimated at about 37-38 inches.

TOPOGRAPHY, GEOLOGY, AND SOILS

The study area elevation, given on Figure 2.1, varies from 4,400 feet at lower Deadwood to 6,400 feet at Terry's Peak. The terrain is very rugged and hummocky. Its steepness is indicative of the area's geology, as explained below. Figure 2.2 shows the terrain in the vicinity of the proposed lower Deadwood plant site.

The geology of the Black Hills is complex, consisting of alternating layers of soft and hard calcium carbonate, cemented sandstone, and erratic igneous intrusives as well as discontinuous layers of clay and silt. The Black Hills is a northwest-southeast trending uplift of Precambrian crystalline rocks, primarily schists and quartzites. Capping the uplift are sedimentary rocks that consist of thick beds of limestone, sandstone, and shale. Also, a northwest-trending belt of igneous intrusives crosses the uplift. These rocks include rhyolite, rhyolite porphyry, monzonite, quartz monzonite porphyries, and a small proportion of phonolite and giorudite. The geologic structure within the study area is shown on Figure 2.3. The predominant rocks are schists and quartzites.

The steep terrain has resulted from the streams eroding through the sandstone and limestone, creating linear and deep canyons from the headwaters of the drainage basins. The talus slopes associated with the igneous intrusives are more resistant to these erosive forces and have thinner soils that support scattered sparse vegetation.

The soils in the area of the project activities are alluvial. These have been overlain with fill material, elevating this area above the flood plain of Whitewood Creek. The alluvium of Whitewood Creek consists of well-graded and fairly clean sand and fine gravel, as well as detached rounded to subrounded boulders. Historical placer and dredging operations along major segments of Whitewood Creek have removed most traces of the natural soil profile and substituted an irregular manmade pattern throughout the upper portions of the creek. Due to the complex geology of the area, it is not possible to speculate on the type of soil that would have developed in any particular area. Different types of parent material typically yield different soils. Limestones yield loamy soils, sandstone produces sandy to loamy soils, and the heavily foliated crystalline rock tends to produce silty soils.

Slide and overland material flows have occurred with regularity in the study area because of the steepness of the terrain, the low shear strength of geologic materials and the incidence of heavy precipitation. Slumping and rotational landslides are also common throughout the study area. The schists and quartzites present the largest potential for landslides because of their low shear strength. These rocks are especially susceptible to movement on steep slopes, such as along streambeds and hillsides where sewer lines and pump stations may be installed. The relatively flat and low-lying plant site should not present a landslide problem.

The possibility of any other geological hazards in the area affecting the proposed action is remote. There is one known geologic fault in the study area, approximately 2 miles removed from the proposed project site. Earthquake activity in the Black Hills is considered minor and infrequent.

One geologic feature that may affect flows in certain reaches of Whitewood Creek is the presence of Pahasapa limestones. This limestone is found in many Black Hills streams, and because of its solubility it causes some streams to intermittently run dry. Whitewood Creek is underlain by Pahasapa limestone the entire length of Whitewood Canyon, which extends from the north Deadwood city limits to Whitewood. Presently, the creek's bottom is sealed by tailings deposits.

HYDROLOGY AND WATER QUALITY

Whitewood Creek's water quantity and quality are the predominant environmental concern in the study area. The existing hydrological condition of the study area is described below in terms of the following factors: surface flow quantities, water supply sources including interbasin diversions, existing water quality, and stream sediment loadings. The impacts of the project are primarily associated with the area's streamflow (referred to as hydrology in later chapters) and water quality.

STREAMFLOWS

The pattern of streams that drain the study area is shown on Figure 1.3. The area's drainage generally consists of the upper reaches of Whitewood Creek and its tributaries prior to reaching Whitewood Creek Canyon north of Deadwood. Whitewood Creek discharges into the Belle Fourche River, shown on Figure 1.2, about 30 miles downstream of the Deadwood Creek and Whitewood Creek confluence in Deadwood. Belle Fourche River is a major tributary of the Cheyenne River. The regional effects of the Lead-Deadwood discharges downstream to Lake Oahe were noted earlier.

Despite the many studies of the Whitewood Creek water problem, there is little available hydrologic data on the creek because of the lack of permanent streamflow stations. The few records that have been kept are summarized on Table 2.4. These flows should be considered as only estimates and should not be relied on for design purposes, determining dilution levels, or other facilities planning calculations.

In an October 1973 study, Wright-McLaughlin Engineers of Denver, Colorado, determined that Whitewood Creek gained flow from the ground water under baseline conditions. They concluded that the observed increasing levels of total dissolved solids (TDS) as the water moved downstream from Lead to Whitewood were due to the inflow of ground water with higher levels of TDS. Their estimated average surface flows in Whitewood Creek were approximately 1/8 to 1/4 cubic feet per second (cfs) upstream of Lead, 15 cfs in lower Deadwood, 17 cfs near Whitewood, and 25 cfs at the confluence with the Belle Fourche River.

Natural flows in Whitewood and Deadwood Creeks are probably very low. Under the present water regime, these flows are significantly augmented by the Lead-Deadwood and HMC discharges. Furthermore, these discharges are water derived from interbasin as well as intrabasin diversions, as discussed later. Also, a geologic factor that may affect area streamflows in the future is the Pahasapa limestones underlying many Black Hills streams. These limestones are aquifer recharge sources and can dry up streams, as in certain reaches of Box Elder Creek. If the tailings that presently line Whitewood Creek are washed out due to improved water quality management of the area's wastes, possible exposure of these limestones may result in intermittent flows.

In addition to streamflows, flood data are important to consider, especially for the protection of sanitary and industrial waste treatment facilities. However, historical flood flow data are also practically nonexistent for the study area. Floods generally occur during the intense snowmelt and rains in the spring and during intense thunderstorms in the summer. The Staven Engineering Company of Rapid City, South Dakota, determined from high water marks that the maximum flood flow was 8,460 cfs. Recently, the State of South Dakota Department of Highways, in conjunction with the USGS, conducted a detailed flood hydrograph study of 80 small drainage basins within the State. Based on their data, the State can correlate flood flows and frequency with basin topography, geology, vegetation, and rainfall characteristics. Table 2.5 summarizes flood flows and frequencies predicted by the State Highway Department for various points within the study area.

Table 2.4
WHITEWOOD CREEK FLOW DATA (1)
(In cfs)

Station and Location (2)	Date Measured	Flow	Comments
1. Near North Deadwood City Limits	7-15-59 3-30-71 5-5-71 6-8-71 6-9-71 6-10-71 10-22-73	15.9 31.9 145.4 68.9 66.3 74.3 16.5	Measured by EPA, reflects high spring flows Measured by EPA, reflects high spring flows Measured by EPA, reflects high spring flows Measured by EPA, reflects high spring flows Measured by EPA, reflects high spring flows Measured by EPA, reflects high spring flows Measured by Wright-McLaughlin
2. Near City of Whitewood	10-18-56 4-18-56 7-17-56 9-18-56 7-15-59 7-31-59 9-7-59 6-10-71 6-11-71	16.0 20.0 15.8 12.5 13.2 21.3 13.2 90.3 73.5	Identified by USGS as base flows Identified by USGS as base flows Identified by USGS as base flows Identified by USGS as base flows Measured by EPA, reflects high spring flow Measured by EPA, reflects high spring flow
3. Discharge to Belle Fourche River	1960-1964 6-10-71 6-11-71 7-20-71 7-21-71 7-22-71 10-22-73	23.3 128.5 101.1 20.4 20.4 20.4 26.4	Average of 106 measurements Measured by EPA, reflects high spring flow Measured by EPA, reflects high spring flow Measured by EPA, reflects high spring flow Measured by EPA, reflects high spring flow Measured by EPA, reflects high spring flow Measured by Wright-McLaughlin

- (1) Measured by the USGS unless otherwise noted.
(2) Station locations are shown on Figure 2.4.

Table 2.5

PREDICTED FLOOD FLOWS AND FREQUENCIES ⁽¹⁾
(In cfs)

Station and Location(2)	Flood Frequency in Years					
	2	5	10	25	50	100
1. Deadwood Creek Near South City Limits	50	120	400	650	1,100	1,700
2. Whitewood Creek Behind County Court- house and Above Deadwood Creek	150	440	750	1,400	2,000	3,000
3. Whitewood Creek Near North City Limits	--	--	1,000	1,600	2,700	3,800
4. Whitewood	--	--	1,050	1,700	2,800	4,000

(1) From January 1975 communications with State of South
Dakota Department of Highways.

(2) Station locations are shown on Figure 2.4.

WATER SUPPLY SOURCES AND DIVERSIONS

Interbasin as well as intrabasin stream diversions are the major water supply for the Lead-Deadwood area. These diversions greatly modify the hydrological regime of Whitewood Creek and its tributaries. The diversion system is owned and operated by HMC. A series of ditches diverts water from the upper reaches of Spearfish Creek (Main Spearfish and Peake Ditches), Rapid Creek (Little Rapid Ditch), and Elk Creek (Elk Creek Ditch), all located on Figure 2.4. This figure also shows the four intrabasin diversions on Whitewood and Deadwood Creeks. Table 2.6 summarizes the quantities of water diverted from each ditch from 1962 through 1974.

All water within the system flows by gravity, except the Main Spearfish Ditch flows, which are pumped 380 feet at the Hanna station. Some of this energy is recovered at the Englewood Power Plant. Water from the Spearfish, Elk, and Rapid Creek drainages and the Clark and Bowen Ditch comprises the potable water supply for Lead, Terraville, Golden Gate, Central City, Blacktail, Pluma, Deadwood, and HMC. The Hearst Ditch supplies nonpotable industrial process water to HMC and the Kirk Power Plant. The Foster and Deadwood Ditches supplied water to the abandoned HMC slime processing plant in Deadwood. Water is currently flowing in the ditch to keep the system from deteriorating. The water is discharged unused to Whitewood Creek at the old slime plant.

Based on Whitewood Creek flow data, the interbasin diversions, averaging approximately 9 cfs since 1962, have comprised approximately 40 percent of the creek's discharge to the Belle Fourche River and as much as 70 percent of the creek's lowest recorded flow in lower Deadwood. When intrabasin diversions are included, total diversions have provided nearly 100 percent of the creek's low flows. This percentage indicates that almost the entire flow of Whitewood Creek below the discharge points is composed of municipal and industrial effluents.

Deadwood currently augments its municipal water supply from the Cutting Mine (along upper Deadwood Creek) and Diamond Springs (in northern Deadwood), as shown on Figure 2.4. Diamond Springs is relatively unimportant because it supplies only about 50 gpm.

In the near future, Deadwood intends to use the Foster Ditch water to replace the supply that is currently pumped from the Cutting Mine. Water supply elsewhere in the study area, notably the Grizzly Gulch community and the Fantail Creek-Nevada Gulch area, comes from private wells.

Table 2.6

FLOW DIVERSION QUANTITIES, 1962-1974
(In cfs)

<u>Diversion Station and Location (1)</u>	<u>Average Flow</u>	<u>Flow Range</u>
Elk Creek Drainage		
1. Elk Creek Ditch	0.31	0.17-0.43
Rapid Creek Drainage		
2. Little Rapid Ditch	0.97	0.44-1.23
Spearfish Creek Drainage		
3. Main Spearfish Ditch	4.84	2.91-6.29
4. Peake Ditch	2.85	2.11-3.28
Whitewood Creek Drainage		
5. Clark & Bowen Ditch	0.97	0.56-1.16
6. Hearst Ditch	0.67	--
7. Deadwood Ditch	1.11 (2)	--
Deadwood Creek Drainage		
8. Foster Ditch	0.67	--

(1) Diversion locations are shown on Figure 2.4.

(2) This diversion was halted in early 1974.

WATER QUALITY

Municipal and industrial wastes have severely polluted the study area's stream system below the Lead-Deadwood and HMC discharge points identified in Chapter 1 on Figure 1.3. Area stream qualities above and below these discharges are given on Tables 2.7 and 2.8, respectively.

Water quality upstream of the major discharges is documented as supporting "diverse communities of aquatic organisms, (1) including a predominance of forms sensitive to pollution." These waters are being affected by septic tank and raw sewage discharges from the five outlying areas indicated in Chapter 1. The Lawrence County Sanitarian has identified three of these areas--Deadwood Creek (Golden Gate/Central City/Blacktail), Grizzly Gulch/Strawberry Creek, and Nevada Gulch/Fantail Creek--as "areas of public health concern." In addition, old tailings and iron-rich porphyry formations subject to surface erosion can be found along the upper reaches of Deadwood, Whitetail, and Whitewood Creeks, which reportedly run "red" during the spring.

No aquatic life is reported downstream of the major municipal and industrial discharges. As indicated earlier, these discharges consist of raw domestic sewage and HMC's sand and slime mill tailings and process water. Chapter 1 has already noted the acres of tailings deposits along Whitewood Creek and the Belle Fourche River. The EPA in its 1972 study stated that no significant deposits were identified outside of the banks of Whitewood Creek between HMC and the north end of Whitewood Creek Canyon. The steep stream gradient in this reach of the stream has kept most deposits within the creek's immediate banks. Another EPA study completed in 1973 determined that the average concentrations of mercury, zinc, copper, and arsenic in these tailings are, respectively, 6, 0, 3, and 200 times greater than background sediments above the influence of Whitewood Creek. The EPA, however, was unable to determine the potential leaching rates of the metals from the sediments.

Little information exists on the quality of ground waters within the area. However, in 1959, the State Health Department determined that 60 percent of the private wells around Lead and Deadwood were subject to human, animal, or surface bacteriological contamination. The EPA determined in 1972 that the heavy metals content of ground water in the study area did not exceed domestic standards and was unaffected by the HMC wastes.

(1) Environmental Protection Agency, September 1971, "Summary and Conclusions," Report on Pollution Affecting Water Quality of the Cheyenne River System.

Table 2.7

EXISTING STREAM QUALITY DATA UPSTREAM OF
HOMESTAKE MINING COMPANY AND MUNICIPAL DISCHARGES (1)

Parameter	Whitewood Creek Above Pluma			Whitewood Creek Above Whitetail Creek		Whitetail Creek Above Deadwood Creek		Grizzly Gulch Creek
	Source A	Source B	Source C	Source A	Source A	Source B	Source D	
Total Suspended Solids	6	--	--	1	3-6	--	0	--
Total Iron	0.16	0.9-5.3	0.26	0.14	0.77-0.78	0.31-0.5	<0.01	--
Total Cyanide	N.D. (2)	<0.02	--	N.D.	N.D.	<0.02	--	--
Total Arsenic	--	0.013-1.0	0.01	--	--	0.0084-0.012	--	--
Total Cadmium	--	0.002-0.05	--	--	--	0.001-0.05	<0.01	--
Total Chromium	--	--	N.D.	--	--	--	<0.02	--
Total Copper	--	0-0.03	0.15	--	--	0-0.01	<0.02	--
Total Lead	--	0-0.56	N.D.	--	--	<0.2-0.65	<0.10	--
Total Mercury	--	0.0002-0.0017	0.0013	--	--	<0.0002-0.0014	<0.2	--
Total Nickel	--	--	N.D.	--	--	--	<0.03	--
Total Zinc	--	<0.02-0.08	0.13	--	--	<0.01-1.11	<0.001-0.007	--
pH (units)	7.8	--	--	7.8	7.3-7.7	--	7.51-7.70	--
Turbidity (JTU)	5	--	--	7	7-8	--	--	--
Chloride	120	--	1	175	102-157	--	4.59-5.67	--
Manganese	--	--	N.D.	--	--	--	--	--
Molybdenum	--	--	N.D.	--	--	--	--	--

(1) Sample results are in mg/l unless otherwise noted and are taken from the following sources:

- A An Evaluation of Pollution in the Belle Fourche and Cheyenne Rivers Due to Wastes Carried by Whitewood Creek. C. A. Thilenius, 1965. Grab sampled February 1963. Results in ppm.
- B Report on Pollution Affecting Water Quality of Cheyenne River System. EPA, 1971. Grab sampled March and June 1971.
- C Investigations of Gold Run Creek Outfall Water. Colorado School of Mines Research Institute, 1974. Grab sampled October 1973. Filtered: 0.45μ.
- D Grizzly Gulch Supportive Data. CH2M HILL, 1974. Grab sampled October 1974.

(2) Not detected.

Table 2.8

EXISTING STREAM QUALITY DATA DOWNSTREAM OF
HOMESTAKE MINING COMPANY AND MUNICIPAL DISCHARGES (1)

Parameter	Gold Run Creek Above Whitewood Creek		Whitewood Creek In Lower Deadwood Area		Whitewood Creek Near Whitewood
	Source A	Source C	Source A	Source B	Source A
BOD ₅	25-70	--	10-100	--	--
Total Suspended Solids	804	--	12,570-15,466	--	--
Total Iron	--	N.D. (2)	--	225-428	--
Total Cyanide	0.6-9.1	--	0.69-2.1	0.50-1.1	0.69
Total Arsenic	--	0.34	--	0.23-1.70	--
Total Cadmium	--	--	--	0.003-0.05	--
Total Chromium	--	N.D.	--	--	--
Total Copper	--	1.3	--	0.11-0.18	--
Total Lead	--	N.D.	--	<0.2-0.70	--
Total Mercury	--	0.001	--	0.0021-0.0080	--
Total Nickel	--	0.02	--	--	--
Total Zinc	--	0.026	--	0.45-0.60	--
pH (units)	8.0-11.7	--	8.4-8.8	--	8.2-8.4
Dissolved Oxygen	4.7-6.1	--	1.5-3.7	--	--
Temperature (° F)	61-63	--	61-72	--	69-77
Manganese	--	N.D.	--	--	--
Molybdenum	--	0.013	--	--	--
Fecal Coliform (No./100 ml)	2.4(10) ⁶ -46(10) ⁶	--	0.43(10) ⁶ -11(10) ⁶	--	--

(1) Samples results are in mg/l unless otherwise noted and are taken from the following sources:

- A Report of Water Pollution Studies, Gold Run Creek-Whitewood Creek, Belle Fourche River-Cheyenne River. South Dakota State Department of Health, 1960. Composite sampled June and July 1959. Results in ppm.
- B Report on Pollution Affecting Water Quality of Cheyenne River System. EPA, 1971. Composite sampled March, June, and July 1971.
- C Investigation of Gold Run Creek Outfall Water. Colorado School of Mines Research Institute, 1974. Grab sampled October 1973. Filtered: 0.45 μ .

(2) Not detected.

VEGETATION AND WILDLIFE

The plant and animal species commonly found in the Black Hills are listed in the Appendix to this report. The following discussion of vegetation and wildlife is from Basinwide Environmental Overview, supplemented by a brief indication of the flora and fauna found on the proposed plant site.

VEGETATION

Vegetation in the Black Hills and the study area is characterized by three major vegetational zones: (1) the coniferous forest, (2) the deciduous woodlands, and (3) the prairie grasslands.

The coniferous forest zone is dominated by ponderosa pine. Most of the pine forest is composed of open park-like stands of trees that are far enough apart to permit an understory growth of such plants as kinnikinnick and juniper. Only in places where the forest is young and growing will the understory be devoid of such plants.

In the cool, moist parts of the canyons are white spruce, a unique plant variety usually found only in the boreal forests of Canada. Interspersed among the white spruce and in locations with greater soil moisture are quaking aspen and paper birch.

The deciduous forests occur on the wide valley floors and canyons. This type of vegetation is composed of American elm, green ash, box elder, cottonwood, and willows. Bur oak is also common to the Lead-Deadwood area. The understory is composed of many shrubs including hawthorn and chokeberry.

The grassland areas are extensions of the great plains flora into the Black Hills. The grass species are mixtures of both the long grasses and short grasses of the prairies. Table A-1 in the Appendix lists the plant species observed in the study area during an October 1974 field survey.

The proposed plant site is a highly disturbed area. It is used for junked automobiles and bulk petroleum product storage. At the northern extreme there is a corral for livestock. At present the site has almost no vegetation with the exception of sparse grasses and several small willows along the western border.

WILDLIFE

Wildlife species known to inhabit the surrounding environs of the Lead-Deadwood area include 216 birds, 54 mammals, 6 amphibians, and 17 reptiles. The presence of most of these species within the study area has not been confirmed, and there is only the potential that these animals may be found at some

point in the study area. Tables A-2 through A-4 in the Appendix list these wildlife species.

Some analysis of the potential for finding an animal within the study area can be made by comparing the species' typical habitat with those known to exist in the study area. A Grizzly Gulch investigation confirmed the presence of nine of the birds and six of the mammals. Major game species present are whitetail deer and turkey.

Of all wildlife species identified in the tables as potentially present, only four of the birds were listed in the Rare and Endangered Species List published in 1971. Three--the bald eagle, the prairie falcon, and the peregrine falcon--have habitats similar to those found within the study area, but all are listed as uncommon or rare residents. The fourth species--the sandhill crane--is a common resident, but its prairie habitat is not found within the study area. It should be noted that the Rare and Endangered Species List is currently being updated and other species present in the area may be added; but currently there is only a small likelihood that any of the four known species will be disturbed.

For the reasons discussed above under "Vegetation," the prospective plant site does not provide a viable wildlife habitat.

HUMAN ENVIRONMENT

LAND USES

The proposed 4-acre plant site is located northeast of the rodeo grounds in lower Deadwood. Most of the site is used for wrecked automobile storage and bulk oil storage. The rest of the site is vacant and is used for rodeo overflow parking during the "Days of '76," an annual community event. The site is 0.25 mile from the nearest commercial development, which includes lodging facilities. The nearest residences to the site are located south of the rodeo grounds. Whitewood Creek is about 0.2 mile west of the plant site. Paralleling the west side of the creek is State Route 14A, the north entrance to the City of Deadwood. The Deadwood Comprehensive Plan designates the plant site area for industrial use.

Residential development is currently scattered in the general project area. Some of this development is located in the valley bottom to the south of the rodeo grounds. Other residences have been located on the valley walls of Whitewood Canyon, especially on the lower and less steep slopes. The majority of these residences are owner occupied on a permanent basis by families with their main income source in the Lead-Deadwood area.

Most of the remaining land in the general study area is privately owned and is unused due to the steep terrain. The uses made of these undeveloped areas range from wood products storage on the slag pile north of the proposed plant site to pasture and forest production to the east. No row cropping or intensive agriculture occurs in the vicinity, although land to the east of Whitewood Creek valley is used for the cultivation of wheat or hay to supplement the cattle feeding operation.

The major transportation corridors in the project area are State Routes 385 and 14A, which are parallel and perpendicular to Whitewood Creek, respectively. State Route 385 connects with Interstate 90 approximately 5 miles west of Whitewood, whereas State Route 14A connects with Interstate 90 at Sturgis. These major arterials generally are located in the valley floor of the predominant drainages. These State routes provide direct access to Lead and Deadwood and to the numerous small county and city roads which traverse the more remote property in the planning area.

Due to the physiographic constraints of the Lead-Deadwood area, it is anticipated that redevelopment of blighted areas, rather than the development of new land, is expected to be the direction for new residential construction in Deadwood. Any new residential development that does occur is slated for the northwestern part of town, i.e., the vicinity of the proposed plant site. At least some residential growth, either redevelopment of existing substandard housing or additional new development, is expected in all major residential areas.

The regional land use patterns summarized briefly below are discussed in the Basinwide Environmental Overview.

Future land use in the region will adhere to existing patterns due to topographic constraints, population stability and projected moderate economic growth. Residential development will tend toward increasing multi-family structures with single-family development replacing some existing substandard structures. Plans have been discussed to redevelop some of the existing commercial structures, with limited occurrence of new commercial activity. Comprehensive plans provide for flexibility for new industrial activity. Little new industrial growth is projected for either Lead or Deadwood.

The development of both permanent and second homes in the basin is a trend that is likely to continue. However, this trend should not create significant economic demands for more public or private services, but rather will make better utilization of existing services, perhaps increasing profitability.

Logging operations will continue to occur throughout the Facilities Plan study area, as will the gravel mining operations. It is not anticipated that "hard rock" mining will increase significantly in the near future.

A substantial majority, i.e., nearly two-thirds of the privately owned land in the Facilities Plan study area, is designated as "park forest," which intends to preserve these areas for their natural beauty, resources and open character. This use will tend to slow development in the area; however, the Lawrence County zoning ordinance is reasonably permissive of the development of single-family dwellings. Much of the remaining Facilities Plan study area is held in public ownership (approximately 40 percent) by either the U.S. Forest Service or the Bureau of Land Management. These publicly owned lands will continue to be available for recreational activities.

SOCIOECONOMIC CONSIDERATIONS

Population

The population of the Lead-Deadwood area is approximately 8,000 persons with a population density of 3.5 persons per acre. As shown on Table 2.9, population has steadily declined since 1940, primarily because of a decrease in labor opportunities. The area's population is expected to be between 8,100 and 9,600 persons by 1990. This range is wide because of uncertainties regarding future tourism levels and labor requirements of the mining industry. Population projections and the projected tourist population equivalent are indicated on Table 2.10.

Economy

Recreation and gold mining are the two major components of the Lead-Deadwood economy. Gold mining is the predominant industry and economic base of the area. Between 1960 and 1970, mining represented between 50 and 60 percent of Lead's total employment. HMC accounts for about 80 percent of the United States gold production and consequently is nationally as well as locally important. Continuing improvements in mining technology and mining low grade ore will tend to stabilize the personnel requirements of HMC. As a result, it is unlikely that the economy of the area will expand significantly.

Tourism in the study area has fluctuated in recent years. However, it is anticipated that the tourist industry could experience modest growth. In addition, part-time residents live in the area for recreational purposes. Visitation to Lead-Deadwood in 1974 was estimated to average 5,700 day tourists and 1,000 overnight tourists. In year-round population equivalents, these statistics amount to 625 and 482 persons, respectively. Deadwood and Lead can accommodate 1,500 and 100 guests, respectively. These communities also serve the 1,400 to 2,000 skiers who visit Terry Peak and Deer Mountain ski areas each weekend during the winter.

Table 2.9
POPULATION TRENDS
OF SELECTED AREAS IN SOUTH DAKOTA
1940-1970 (1)

Area	1940	1950	1960	1970
Central City	302	218	247	188
Deadwood	4,100	3,288	3,045	2,409
Lead	7,520	6,422	6,211	5,420
Total - 3-City Area	11,922	9,928	9,503	8,017
Percentage Change From Previous 10 Years		-16.7	-4.3	-15.6
Spearfish	2,139	2,755	3,682	4,661
Percentage Change From Previous 10 Years		28.8	33.6	26.6
Lawrence County	19,093	16,648	17,075	17,453
Percentage Change From Previous 10 Years		-12.8	2.6	2.2
South Dakota	642,961	652,740	680,514	666,257
Percentage Change From Previous 10 Years		1.5	4.3	-2.1

- (1) Information from U.S. Department of Commerce, Bureau of the Census, *Census of the Population, South Dakota, 1950, 1960, and 1970*; Business Research Bureau, School of Business, University of South Dakota, May 1972, *South Dakota Economic and Business Abstract*.

Table 2.10

POPULATION PROJECTION
LEAD-DEADWOOD SANITARY DISTRICT NO. 1
INCLUDING FANTAIL-WHITETAIL

Population	1970	1990 Projection		
		Brady Engineering (2)	CH2M HILL (Preliminary)	
			Low	High
Resident (including Fantail- Whitetail) (1)	9,160	10,440	8,100	9,600
Tourists (Population Equivalents)	<u>1,107</u> (2)	<u>1,640</u>	<u>900</u>	<u>1,200</u>
Total Population Equivalents	10,267	12,080	9,000	10,800

- (1) Does not include necessary population equivalents to handle wintertime recreational load on Whitetail-Fantail-Nevada Gulch area. This additional load will only affect the interceptor size and not the system load because of the decrease in the tourist load during the winter.
- (2) Preliminary Engineering Report - Wastewater Treatment Facilities for Lead-Deadwood Sanitary District No. 1, Brady Engineering Company, 1971.

A recent shift of population from urban places to rural areas and small communities has been noted. This shift may stimulate economic activity in the new areas of settlement. However, demographers are not yet capable of clearly identifying the attributes that attract exurbanites to rural communities. Should this trend continue, communities like Lead and Deadwood may prove to be suitable areas for resettlement.

HISTORICAL/ARCHAEOLOGICAL

No known historical or archaeological sites are located in the immediate project area. However, the entire study area is a significant historic site in that many popular American folk heroes resided in or passed through Lead and Deadwood. These events have been recorded in local history documents and popularized in print and electronic media. The communities have made significant efforts to retain their historical ties and offer the tourist an opportunity to experience the events of the past. Most of the historic remains in the area are related to the gold rush days that began in the mid-1870's. The sites, listed in the Basinwide Environmental Overview report, include old mining settlements, mining activity locations, railroads, and cemeteries. Both the City of Lead and the City of Deadwood have been included as National Historical Districts on the National Register of Historic Places.

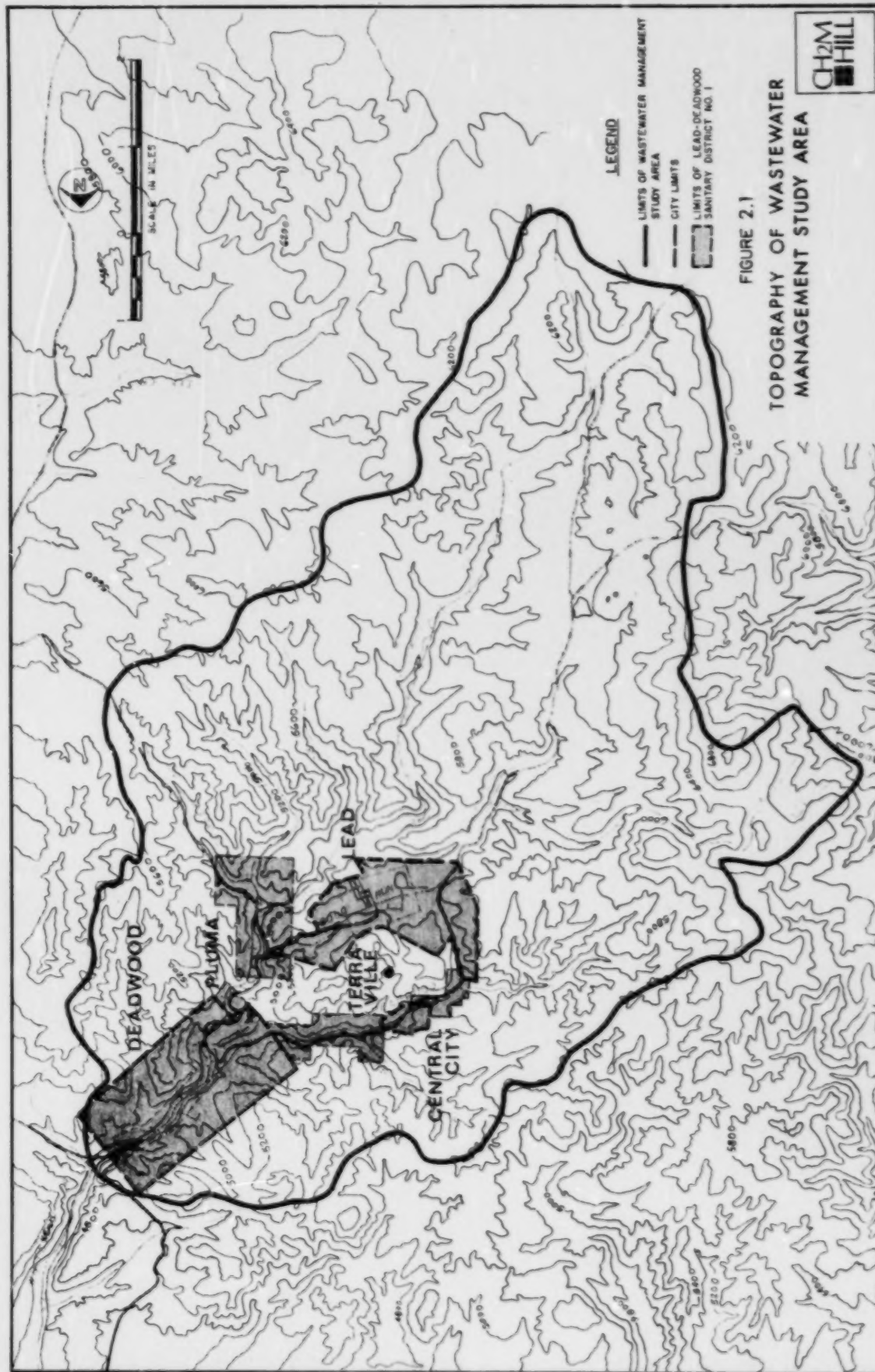




FIGURE 2.2

TERRAIN IN VICINITY OF
PROPOSED LOWER DEADWOOD PLANT SITE

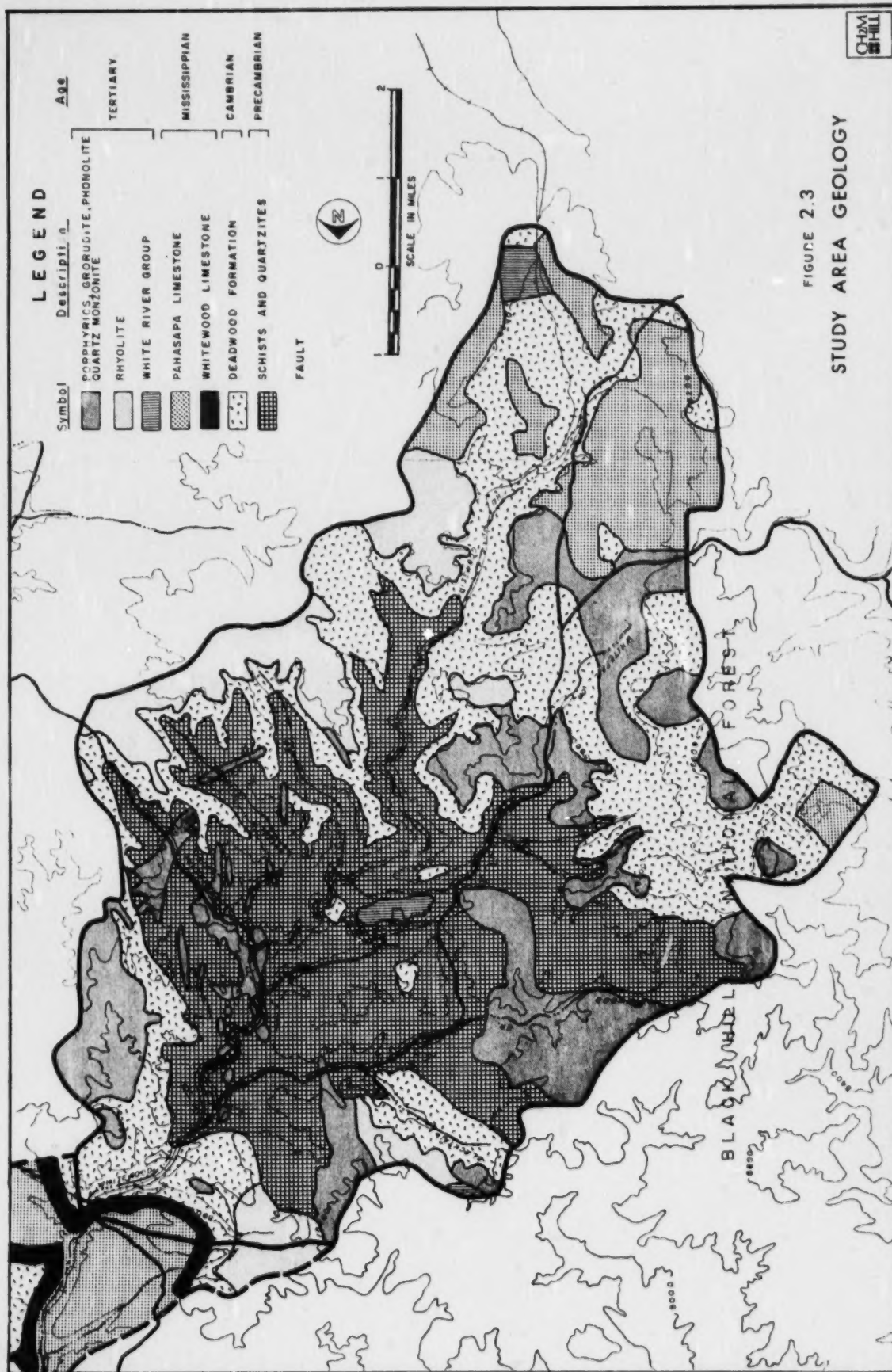
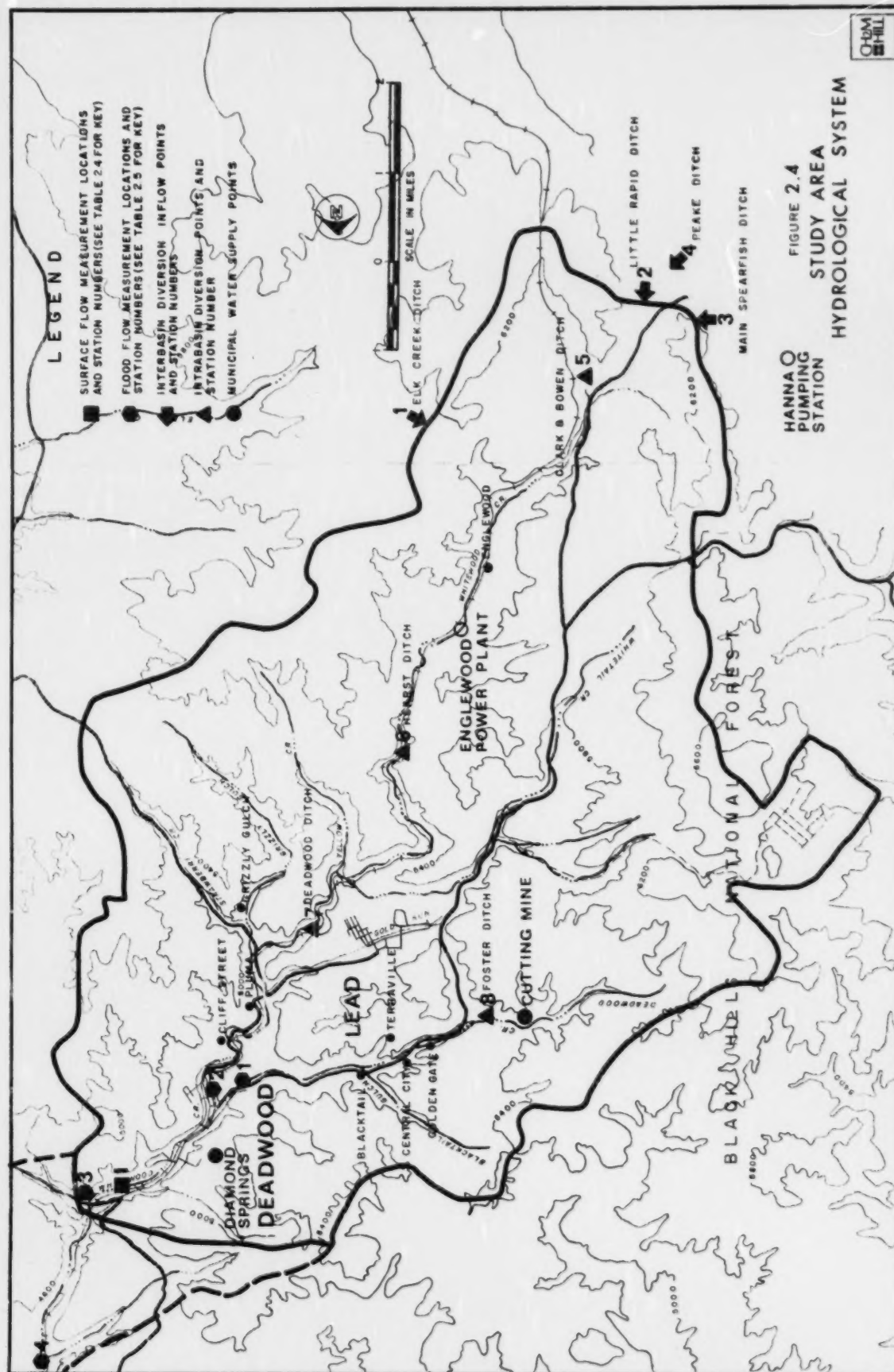


FIGURE 2.3
STUDY AREA GEOLOGY

CHAM
HILL



Chapter 3 ENVIRONMENTAL IMPACTS

The project's environmental impacts are summarized on Figures 3.1 and 3.2. As indicated by these figures and in the following discussion, most of the adverse impacts will result from the construction activities and will therefore be only temporary. Overall, these adverse effects will be offset by the long-term environmental benefits of the project once it is in operation. The temporary inconveniences due to construction are evaluated to be insignificant compared to the benefits of eliminating raw domestic sewage discharges into area streams and improving the severely degraded condition of Whitewood Creek.

This chapter discusses the potential environmental impacts in terms of the three major project components--the extended sewer service, the pump stations, and the treatment plant. Generally, for each component, the construction impacts are presented first, and then the effects of the project once it is implemented are evaluated. Possible mitigation measures are also discussed.

No detailed consideration is given to the effects of importing 18,000 cubic yards of fill material. The extent of any adverse impacts cannot be determined until the borrow area is specified. In general, excavating fill material from a borrow area is expected to have some degree of impact on the area's geology, soils, vegetation, and wildlife.

SOIL, GEOLOGY AND AIR QUALITY

IMPACTS

The major geological concern is the potential for soil erosion and slope instability because of the area's steep terrain. About 50,000 feet of pipeline construction will be required, including extension of sewer lines into presently unsewered areas and rehabilitation of interceptors in selected areas. Soil erosion and general geological disruption will be problems all along the pipeline corridors, especially where slopes are steep. Areas of greatest potential impact are Central City and the slopes of South Lead where five pump stations will be installed in the Pavilion, Matthew and Canyon Street areas. Soil erosion will persist along the pipeline and around the pump station sites unless soils are stabilized or until natural vegetation is reestablished.

Excavation and use of large machinery for installation of sewers will cause minor local dust problems, and increases in vehicular emissions will also have a minor impact on air

quality. These problems will be negligible in most areas but may cause inconvenience where construction takes place near homes and commercial activities, principally in Deadwood and Pluma.

Construction of the plant at lower Deadwood will also present erosion and dust impacts. Erosion impacts onsite should not be important because the site is level, and erosion that does occur can be controlled through proper management. During the 2-year construction period, dust and air quality impacts will result from site preparation, importation of fill material and vehicular movement. Long-term air quality impacts from increased vehicular movement to the plant (due to commuting employees and supply deliveries) will be localized and negligible.

The most significant erosion impact from plant construction will result from excavating 18,000 cubic yards of fill material. This material will obviously have to be mined from some other area. Without careful management and restoration, the borrow area will be subject to severe erosion. However, detailed analysis is not possible until the borrow area and extraction methods are identified.

MITIGATION

Many of the potential soil and geological impacts described above can be lessened with appropriate planning. Before project construction, a geotechnical investigation should be made of the proposed pipeline corridors and pump station and treatment plant sites. The study should recommend ways to avoid sensitive geological areas.

Erosion

Construction activities, particularly in hilly areas and along streambeds, should be limited to the dry season whenever possible. When construction must continue during the rainy season, erosion control measures should be used. The amount of exposed soil should be kept to a minimum and revegetation should commence immediately. Temporary methods of slope stabilization, such as mulching, netting and runoff diversion, should be used until permanent vegetation is established. Limits will also be established on the amount of exposed earth allowed during the winter. Prior to project initiation detailed erosion control plans should be drawn up and submitted.

Slope Stability

Construction should avoid areas with known slope stability problems, where possible. In potential problem areas that cannot be avoided, slope stabilization should be provided by (1) buttressing the toes and sides of slide areas with compacted

soil or retaining walls, including subsurface drainage where applicable, (2) removing and/or redistributing part or all of the existing landslide debris, especially from the top of the slide and (3) retaining an engineering geologist during all construction activities where cut slopes or fill slopes are planned.

The borrow area should be chosen to minimize adverse geological impacts due to extraction of fill material. One possibility is the proposed HMC tailings pond site, which is already planned for inundation. Extraction of fill for the lower Deadwood plant site would increase the capacity of the tailings pond.

WATER QUALITY

IMPACTS

Installing the collection system may cause some sedimentation and corridor damage in Whitewood Creek and its tributaries. Due to the mountainous topography, the interceptors must follow roadsides or area creeks. However, sedimentation due to project construction should not be noticeable for the most part because of the presently extremely polluted stream conditions. Adverse water quality effects will be felt mostly along several small segments of relatively unspoiled water courses, principally the upper reaches of Whitewood, Strawberry, and Grizzly Creeks above Pluma and the uppermost segments of Deadwood Creek. Construction of the treatment plant will have no adverse impact on water quality. Plant construction at lower Deadwood will require rechannelization of Spruce Gulch, a small swale that crosses the proposed site.

The potentially harmful impact of sedimentation is insignificant compared to the improved water quality that will result once the project is in operation. Sewerage service will be extended to presently unsewered areas (Strawberry Creek, Grizzly Gulch and Deadwood Creek) where inadequate septic systems now degrade both ground and surface waters. Protection of private wells will also result. In addition to this septage, the treatment plant will eliminate the numerous direct discharges of raw domestic wastes to Deadwood, Gold Run, City and Whitewood Creeks. The plant, through secondary treatment and nitrification, will with proper management eliminate 30 percent of Lead's and Deadwood's domestic waste loads from the water regime. The remaining waste loads should not be a problem during normal streamflows when adequate dilution is available. However, it is not known if low streamflows will provide enough dilution to prevent fish kills. Presently, sufficient flow data are not available for estimating low flow in Whitewood Creek. Water quality will improve most between the south Lead city limits and the lower Deadwood plant site because all domestic

discharges will be stopped along this reach. Below the treatment plant, water quality may not be as high as above the plant but will still be significantly better than existing conditions.

There are some uncertainties concerning water quality impacts associated with storm events. Under the proposed collection system, Lead will continue to have a combined sanitary and storm flow sewer system. The combined sanitary and storm flows in Lead are huge during high runoff periods and could not be accommodated by the proposed treatment plant. Storm water treatment will require the construction of a flow equalization impoundment and possibly a separate treatment facility. Flow equalization facilities, however, have not been included in this phase of the Facilities Plan because of high costs, so during some storm events combined sanitary and storm flows from Lead will be discharged directly to Gold Run Creek, a major tributary of Whitewood Creek. The water quality of the combined flow discharges will be dominated by the storm runoff quality. The quantity of storm runoff will be 10 to 20 times larger than the amount of domestic sewage present during periods of bypass. Direct bypass of these flows may degrade water quality, but whether water quality will be depressed sufficiently to cause fish kills is now undocumented.

One other unknown about water quality impacts is the possible development of cyanogen chloride during the treatment process. The proposed treatment plant is not designed to remove cyanide, a constituent which is not normally found in domestic wastewater but is present in Deadwood's waste flows. The proposed treatment process will probably remove some cyanide; however, exposure of cyanide to chlorine (used for effluent disinfection) may form cyanogen chloride, a compound which is extremely toxic to fish life. If cyanide continues to be a problem, the use of ozonation in place of chlorine for disinfection may be necessary.

Heavy metal standards will not be violated unless the background levels of these constituents are higher than anticipated. Although the proposed treatment system is not designed to remove heavy metals, some minimal amount of removal can be expected.

MITIGATION

The amount of stream sedimentation due to pipeline construction can be minimized by paralleling roadways rather than streams as much as possible. However, this mitigation measure would increase the adverse impacts on traffic circulation. Ideally, pipeline construction should avoid the upper unspoiled reaches of Whitewood, Strawberry, Grizzly and Deadwood Creeks. Otherwise, as suggested in the geology discussion, excavation should take place during the dry season to reduce potential erosion and

sedimentation impacts. If construction and the wet season coincide, sedimentation basins, soil stabilization measures and/or other erosion control measures should be used.

Establishment of a monitoring program is recommended to provide information on existing instream water quality and to build a data base for documenting the future recovery of Whitewood Creek.

The impact of bypassing storm water to Gold Run Creek could be lessened if the quality of that wastewater is improved. This could be accomplished by street cleaning programs, or by curtailing the use of mine tailings and salt for ice control.

Last, the possibility of treatment plant upsets would be reduced by development and enforcement of ordinances restricting the discharge of potentially toxic wastes to the sewer system. Programs for judicious disposal of problem waste could be initiated.

HYDROLOGY

IMPACTS

As described earlier, interbasin and transbasin diversions and discharges of municipal and industrial wastewater supplement the natural streamflows in the Whitewood Creek regime. These factors increase the stream's average flow to about 15.0 cfs in the reaches through Deadwood. The creek is basically a gaining stream--ground water flows to rather than away from the streambed--and average flows increase to 25 cfs at the confluence with the Belle Fourche River.

Streamflows will be altered by proposed municipal and industrial pollution abatement programs. For example, HMC is planning to recycle their waste flows and will reduce or eliminate discharge to Gold Run Creek. This recycling will reduce the flow in Whitewood Creek by up to 7.5 cfs. Collection of Lead's wastewater for treatment in lower Deadwood will dewater the reach of Whitewood Creek between Lead and Deadwood by an additional 2.3 cfs. Therefore, the segment of stream between the two cities will be dewatered by nearly 10 cfs, or by about two-thirds of its average flow. Below the plant the stream will still be dewatered by up to 7.5 cfs because of HMC's water recycling program. The impact of these hydrological changes will be more predictable after low flows in Whitewood Creek are more carefully recorded.

MITIGATION

Low flow water augmentation of Whitewood Creek would be possible if HMC continued to divert water from the Spearfish basin. Presently, HMC diverts about 5.0 mgd from that basin for gold

ore processing. After invocation of their proposed water reuse system, only about 1.0 mgd will be needed. Presently, there is no incentive for HMC to divert the additional 4.0 mgd to simply augment Whitewood Creek flows. Moreover, augmentation is not necessary during much of the year because the creek has sufficient natural flow to maintain a viable aquatic ecosystem.

However, during drought periods, it is possible that Whitewood Creek will dry up; this would obviously negate the development of a fishery there. Negotiation could be undertaken with HMC to divert and discharge the extra 4.0 mgd to Whitewood Creek for flow augmentation during low flow periods. If HMC does not need the water for industrial purposes, the water may be acquired for only the costs of diversion.

VEGETATION AND WILDLIFE

IMPACTS

Construction of the proposed collection and treatment system will have some short-term negative impacts on localized vegetation and wildlife, but these undesirable effects will be offset by the long-term environmental benefits.

Development of 50,000 feet of pipeline will require disruption and removal of vegetation. This disturbance will be especially noticeable along Strawberry and Grizzly Creeks and the upper reaches of Whitewood Creek above Pluma. Depending on the interceptor route chosen, similar vegetative losses may occur along Whitewood Creek below Deadwood. In most cases the plant life temporarily lost will be grasses and brush; losses of small trees may occur in selected areas. Likewise, installation of the five pump stations along the south slope of Lead may require removal of several spruce. However, selective siting of both interceptor routes and pump stations could minimize vegetative losses.

Except in one possible area, adverse impacts on wildlife due to interceptor and pump station development will be negligible because the proposed corridors and sites are located within the urban environment. On the other hand, installation of a new interceptor along the reach of Whitewood Creek between Grizzly Gulch and Pluma may have a short-term impact on the fishery there. Because the principal problems will result from water turbidity and stream bank disruption, impacts could be alleviated through environmental planning and proper erosion control.

Construction of the 2.33-mgd secondary treatment plant will disrupt approximately 4 acres. The prospective site is now used for the storage of wrecked automobiles and, in part, as a parking lot for the adjoining rodeo grounds, so impacts on

vegetation and wildlife will be minimal. Small parcels of brush and several scrub oak and/or willows adjacent to Spruce Gulch may be removed by construction. After project completion, the site will be landscaped and vegetation replaced, probably resulting in a net increase of onsite plant life.

Once in operation, the project will undoubtedly have a positive impact on local and regional wildlife. The Whitewood Creek regime will be relieved of raw discharges of domestic waste. (Industrial wastes will be removed through HMC's planned pollution abatement program.) After implementation of the planned cleanup programs, Whitewood Creek should be capable of supporting some forms of aquatic life with time.

The ability of Whitewood Creek to support a fishery is uncertain. Existing tailings deposits, water temperature, and physiography of the creek may negate efforts to resurrect the creek.

The existing tailings deposits will continue to be a problem for many years after HMC's cleanup program. Tailings may secrete heavy metals that are toxic to biotic life. In addition, once HMC discontinues its discharge of tailings into the stream, the creek will seek new equilibrium through downcutting and bank erosion. As a result, existing tailings may be resuspended and carried downstream at a faster rate than they are now. This purging may eventually expose the older tailings and cause excessive concentrations of mercury in the stream's water since HMC previously used mercury for gold recovery.

The stream characteristics are not conducive to warm water fish. Thus, if a fishery is to be developed in Whitewood Creek, it will probably have to be of the cold water classification. A cold water fishery may require levels of water quality which can only be achieved with domestic tertiary treatment systems and storm water treatment, concepts which are currently considered cost-ineffective for the Lead-Deadwood area.

Last, Whitewood Creek is a high gradient stream with few undercut banks, ponds or riffles and therefore provides poor habitat for fish life. However, a habitat improvement program could be initiated to provide the pools and other physical features required.

Although development of a cold water fishery in Whitewood Creeks does not look too promising, the proposed project will provide many environmental benefits. Even if trout cannot be established in the creek, many insect, amphibian, reptile and nongame fish species will reinhabit the stream corridor. These organisms will supplement the local food chain and benefit higher forms of life such as shore birds, water fowl, birds of prey and semi-aquatic and terrestrial mammals.

MITIGATION

With the exception of pipeline construction along Strawberry, Grizzly, and upper Whitewood Creeks, the development of the proposed sewerage system is not expected to adversely affect vegetation and wildlife. Because these stream reaches are unspoiled and do support aquatic life, they should be protected from construction impacts. The pipeline should not parallel the streambeds but should run along the shoulder of the roads or be built at some point between the road and the stream. The opportunity for alternative routes will vary at different points along the creeks. In cases where the pipeline will affect the streams, erosion control measures as discussed earlier should be practiced.

SENSORY IMPACTS--AESTHETICS, ODOR AND NOISE

IMPACTS

Extension of sewers to unsewered areas and the paralleling and replacement of existing sewers will tear up roads and lawns where the pipeline crosses developed areas. The impacts will be significant throughout southeastern and northeastern Lead, Grizzly Gulch, Pluma and Deadwood. However, the most severe impact will be felt by persons residing in Central City because the topography is steep, requiring extensive excavation and possibly blasting for construction.

Likewise, installation of the five pump stations in Lead will affect local visual quality both during and after construction. The construction process will require excavation and some (probably minor) removal of vegetation. Once in operation these facilities will be inconspicuous and with proper landscaping inoffensive visually. The pump stations will have electric pumps, causing very small increases in local noise levels. The proposed pump stations will not cause odor problems unless shutdown.

Building a \$5.4-million facility will involve an extensive construction effort. Site preparation, importation of fill material, and erection of the structures will increase noise, local traffic and dust. The construction work should not be any more visually offensive than the existing wrecked car lot; however, the construction noise, traffic and dust may temporarily affect nearby motels and businesses.

Locally, concerns have been expressed regarding the plant's aesthetic impact and odors, and possible conflicts with the Deadwood rodeo grounds once the plant is built and in operation. These concerns have been considered in the design of the plant and are discussed below under the mitigations section.

Although the proposed project will have some adverse sensory impacts during the construction phase, community aesthetics will be significantly improved by its implementation. The collection and treatment system will eliminate odors caused by the discharge of raw wastes to area creeks and by malfunctioning smhoff tanks in Lead. Also, cleaning up Whitewood Creek will improve the visual quality of the Lead-Deadwood area.

MITIGATION

Aesthetics

Little can be done to mitigate the visual impact of construction activities except for expediting the work. After construction the pipeline corridor should be promptly replanted with native vegetation. Also, during construction of the pump stations only a minimum of vegetation, especially trees, should be removed. The pump station structures should be finished in natural or earth-colored materials. For example, wood security fencing would be more subtle visually than would the traditional chain link fence. Revegetation with natural species would also reduce adverse aesthetic impacts.

Local aesthetics will obviously be altered by the proposed plant but should be an improvement over the visual impression of the car wreckage now stored on the site. Due to the local concerns, the plant, including all major process units, will be enclosed and the site landscaped. Consequently, it will resemble a municipal administrative building rather than a typical treatment plant.

Odor

Traditionally, sewage treatment plants generate obnoxious odors when they malfunction due to mismanagement or to the introduction of toxic materials (usually illegally discharged by industry) into the waste stream. Lead-Deadwood wastewaters are almost entirely domestic, so plant upsets resulting from problem waste loads should not occur with proper management. Also, no serious management problems are expected, because the secondary plant operation is not complex as is a tertiary plant. Finally, odors will not result during routine plant operation or during a possible procedural upset, because all treatment components will be enclosed and odor control will be provided. Thus, plant odors should not interfere with public enjoyment of rodeo ground events.

To minimize possible odors, the pump stations should be designed with auxiliary power and duplex pumps. Installation of an alarm system connected to the treatment plant to indicate pump failure would allow quick repair and help avoid overflows.

Noise

Construction noise is, for the most part, an unavoidable impact. However, noise impacts can be reduced by (1) installing noise reduction mufflers on all construction equipment, (2) scheduling all construction activities between 8:00 a.m. and 5:00 p.m., and (3) rerouting as much construction traffic as possible away from noise sensitive areas.

LAND USE

IMPACTS

A basic land use issue confronting the proposed project is its use of scarce land resources. Deadwood's Comprehensive Plan indicates that the prospective plant site is to be preserved for industrial uses. Placement of the sewage treatment plant on the site will not violate this plan. However, Deadwood is actively soliciting industrial growth, and due to topographic constraints, land for such development is scarce. The plant site is the largest contiguous industrially zoned parcel in Deadwood. Consequently, some citizens feel that use of the site for sewage treatment will, in effect, reduce the area's chance for industrial development. It is their opinion that the proposed facility should be located elsewhere (even if major sewage pumping is required) to keep the lower Deadwood site for other purposes.

There is no way to avoid the plant's consumptive use of scarce land resources in the service area except to not build the plant or to build it outside the area. Alternative treatment methods and plant sites were thoroughly investigated during the facilities planning process. On the basis of engineering and cost considerations, the proposed site was chosen as the best location.

Two other land issues involve possible conflicts with the rodeo grounds and nearby business and with Highway Department properties. The site's proximity to the Deadwood rodeo grounds and several motels and small businesses has raised a concern about plant odor and conflict with available parking space at the rodeo grounds. Also, use of the site for a treatment plant may conflict with future expansion of Highway 14 and the development of a highway storage yard and maintenance shop.

MITIGATION

Except for the plant's use of the industrial land, the project's land use conflicts can be resolved. As mentioned earlier, the major unit processes of the proposed plant will be covered to control odors, even in the event of plant upset or failure. Reductions in available parking for rodeo events will be

negligible because the majority of the treatment facility will be built on the wrecked car lot, which is currently not available for public parking. Finally, the plant site has enough room for both the treatment facilities and an expansion of Highway 14. This joint use of the land can be possible through negotiation.

SOCIOECONOMIC

IMPACTS

Construction of interceptors will disrupt portions of Deadwood, the community of Pluma, and to a less extent the City of Lead. To varying degrees, business and sales in these areas will be impaired because roadways will be torn up in places and possibly closed and construction vehicles will congest local circulation. These impacts will be especially noticeable because construction will occur during the height of the tourist season in the summer.

To somewhat offset the negative short-term impacts on local business, the project will represent a major influx of construction dollars. Of the estimated \$5.4 million to build the facilities, 77.5 percent will be financed by the Federal and State governments. In theory, this amount of money can result in a net influx of \$4.2 million into the Lead-Deadwood economy. About 50 to 75 new jobs will be created during the construction of the project. The actual impact on the area's economy will depend in part on the number of workers hired from within the Lead-Deadwood communities and where they spend their earnings. If the majority of workers live outside the service area, benefits to the Lead-Deadwood economy will be reduced.

Construction of the treatment plant will also have temporary adverse impacts, such as increased noise and dust, that may affect occupancy at nearby motels in lower Deadwood. Because the construction site is, at a minimum, 0.25 mile from the closest motel, impacts on occupancy should be insignificant. Also, the special provisions for an inoffensive plant appearance and odor control will assure that the plant will not interfere with businesses during plant operation.

The long-term impacts of the project on the human environment are for the most part beneficial. First, the improved sewerage service in the Lead-Deadwood area will help protect public health. Because many of the area's streams function as open sewers, exposure to viruses and pathogens presents a threat to the public. Also, contamination of private wells by malfunctioning septic systems has been documented in portions of the service area. Collection and treatment of the area's domestic wastes will eliminate these problems in the service area.

Increased values of local real estate and opportunities for new housing and business development are a second major benefit provided by the proposed plan. An aesthetically pleasing Whitewood Creek, a major physical feature of the Lead-Deadwood communities, will add to the area's desirability, encouraging people to reside and do business in the service area rather than in surrounding communities.

A third and even more important benefit is that the provision of a federally acceptable sewerage system will qualify the Lead-Deadwood area for FHA home financing, which is presently unavailable there. Because the area is not now eligible for this money, the communities have a housing shortage, and 30 percent of the existing homes are "substandard." As a result, prospective home buyers seek real estate in surrounding communities, as evidenced by the fact that about 1,000 persons have moved out of Lead and Deadwood to Sturgis, Spearfish and Whitewood during the past 5 years.

Although the social benefits of the proposed project are evident, families on fixed incomes, especially the elderly, may find the \$9.61 per month sewer utility charge excessive. Increased sewer bills may force fixed income people to reduce the amount they spend on food and medical care. The high cost of wastewater treatment in the Lead-Deadwood area may result in failure of the bond referendum and frustrate attempts to improve the area's environmental quality.

MITIGATION

Most of the construction impacts that will impair local business are unavoidable. They can be reduced, however, by some commonsense construction procedures. Where interceptors are laid along streets, a minimum of one lane of traffic should be kept open and the installation should be as expeditious as possible. Also, the mitigation measures mentioned in the previous section entitled "Sensory Impacts" are applicable here.

To assure that the Lead-Deadwood area receives maximum benefit from the influx of Federal and State construction money, local workers should be hired to build the project. Also, when possible, materials required for construction, such as cement, aggregate, lumber, and rebar, should be purchased from local or regional suppliers.

The impact that higher sewer utility rates may have on fixed income households will be unavoidable unless other sources of funding are available. One possibility is to charge the elderly and other fixed income groups less than those with the ability to pay more for sewerage service. This alternative, however, is expected to be hard to implement.

SECONDARY IMPACTS

Recently environmentalists, local officials and Federal regulatory agencies have become concerned over the possible "overdesign" of wastewater treatment facilities sponsored under PL 92-500. If a facility is oversized, the funding agency may be helping to pay for future development and may be financing projects that result in environmental degradation due to growth. Public officials wish to avoid "overdesigned" facilities because this often commits their cities to growth in order to meet bond indebtedness. Obviously, if growth does not occur, financial obligations for sewage treatment can present a serious burden.

Adequate sewage treatment, as well as other public utilities, is one of the many elements that can determine growth in a community. In a free enterprise society, the other and usually more important elements that affect growth are business and household decisions and transportation choices. Depending on the balance of all these elements, utilities can play varying roles in future development.

At one extreme, a utility such as sewage treatment can cause growth if excessive public investment causes an unbearable tax burden for existing populations. Measures to encourage additional population (for an increased tax base) are often implemented as a result. But encouraging growth often just exacerbates the problem because other utilities and municipal services must also be provided for the new residents. As a rule, increased residential growth as a means for financing large utility expansions increases the local tax burden.

At the other extreme, a lack of adequate sewage treatment can prevent growth, especially when the lack of the utility is perceived as injurious to public health and welfare. In such cases, moratoria on sewer hookups and building permits, as well as other growth controls, are often invoked. However, if the lack of a given utility does not endanger the public, failure to provide it will not usually prevent growth.

At points between these extremes, utilities represent a commitment to or at least a recognition of new development. Growth is imminent as a result of other forces and would only be served, not encouraged by the proposed utility. Factors such as job opportunities, the desirability of the area, housing, taxation and availability of transportation play the dominant role.

The proposed sewage treatment and collection system is not expected to stimulate growth or alter land use in the Lead-Deadwood area. As noted earlier, the Lead-Deadwood economy is dependent on mining, namely HMC, and to a lesser extent tourism. Neither of these activities is expected to significantly

increase in the future. Therefore, a relatively stabilized population has been assumed for designing plant capacity.

Both high and low population projections were presented in Chapter 2. The "high" estimate for 1990, though somewhat optimistic, was chosen for the design of the proposed sewerage facility. It will handle the present resident and tourist population of 10,267 and will provide for a future population of 10,800, or for a net increase of 5 percent between 1970 and 1990. The high projection assumes that HMC labor requirements will increase slightly with the reactivation of Bald Mountain Mine and that tourism will be slightly above its 1970 level. Because the proposed sewerage facility will be designed for no more than a 5-percent increase in population, it is evident that it will not stimulate influxes of population or change the land use goals.

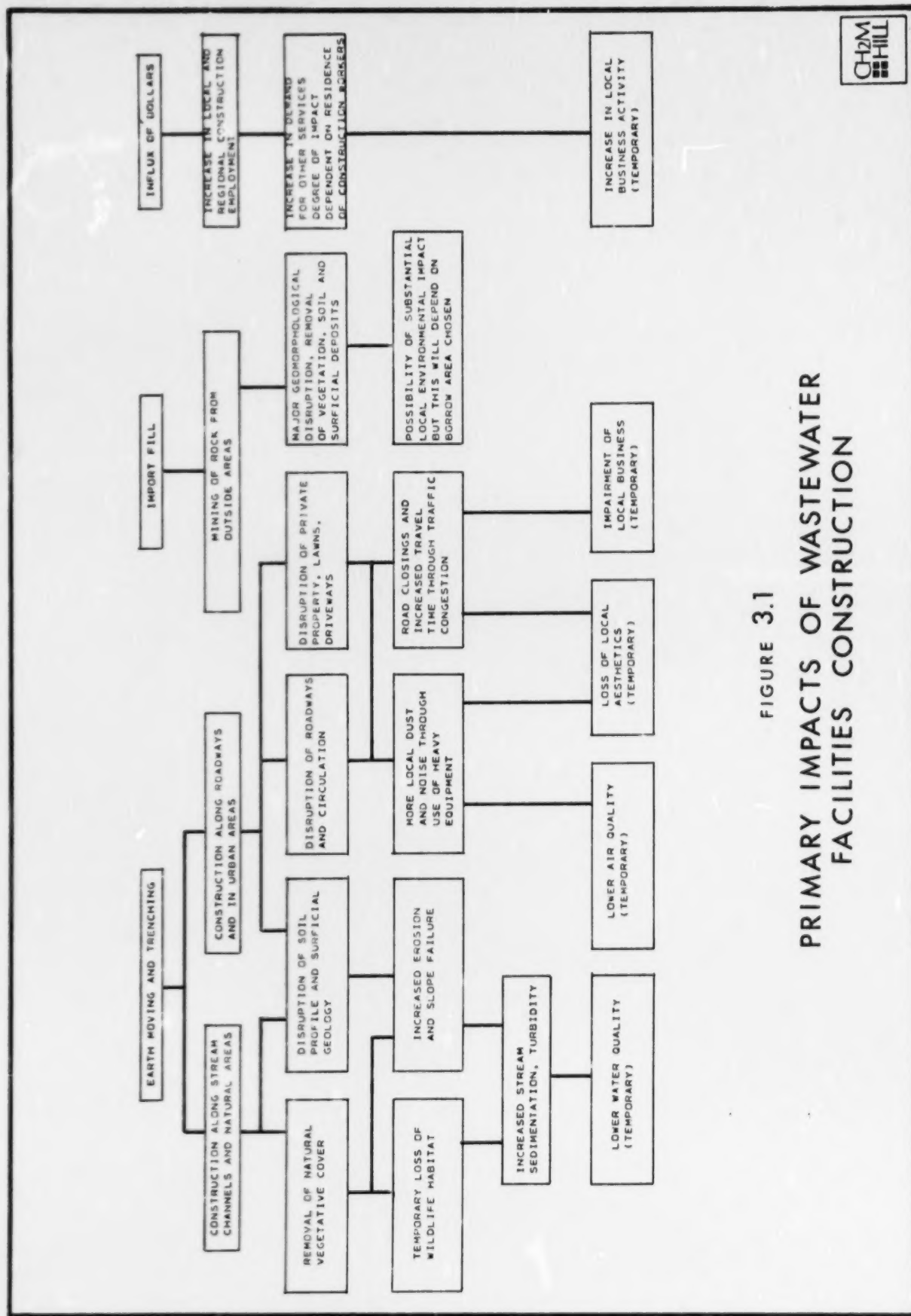


FIGURE 3.1
PRIMARY IMPACTS OF WASTEWATER
FACILITIES CONSTRUCTION

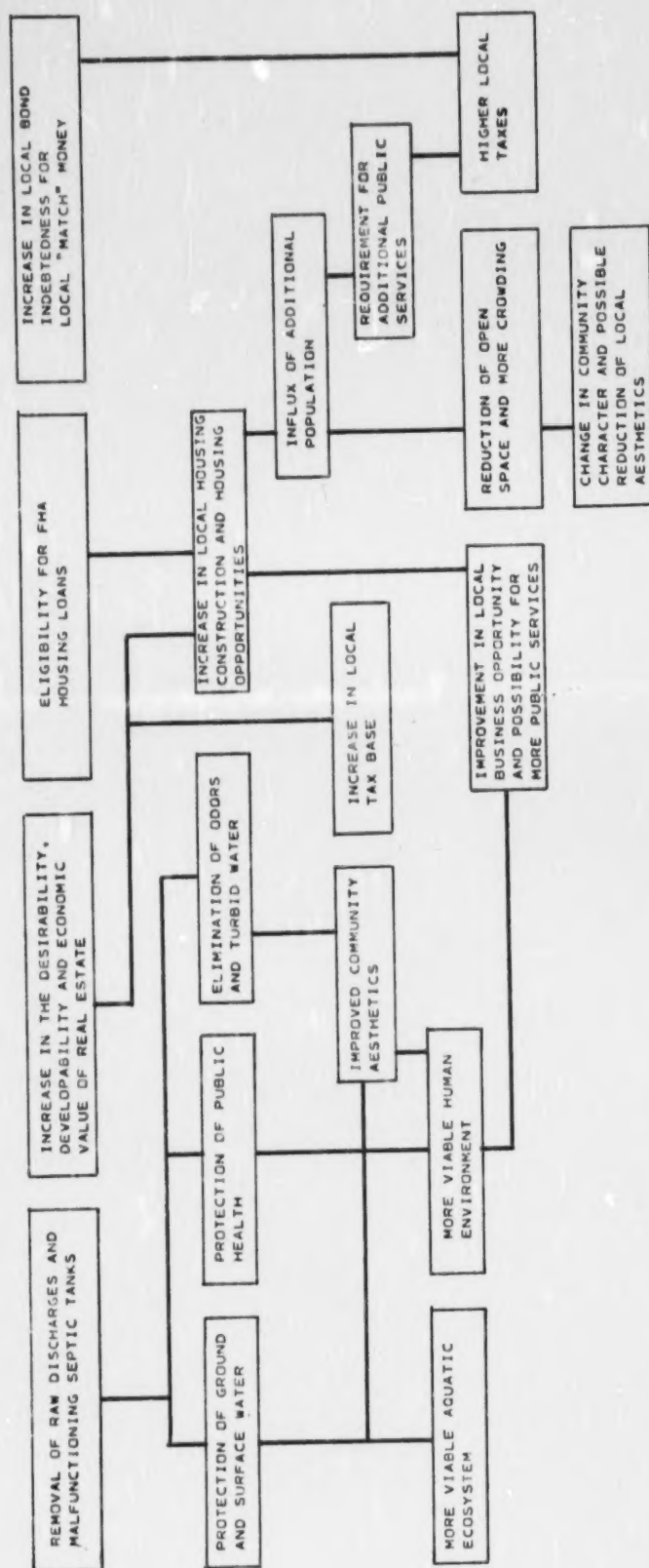


FIGURE 3.2
OPERATIONAL AND SECONDARY IMPACTS
OF WASTEWATER MANAGEMENT

Chapter 4

SHORT-TERM VS. LONG-TERM IMPACTS

The proposed wastewater management project will have many environmental benefits with no identifiable long-term environmental detriments or foreclosure of future environmental uses. Monetarily, the local cost of providing sewerage service, though relatively high, is more than offset by project benefits. Furthermore, the short-term adverse construction impacts are considered a worthwhile investment to achieve the wastewater management goals of the project.

Construction of the proposed project represents a long-term solution to controlling pollution from municipal wastewater. By contrast, continuing the present practices of discharging raw sewage to Whitewood Creek will result in further degradation of Whitewood Creek. Moreover, pollution problems, especially odor, will be exacerbated after HMC implements its pollution control programs. Presently, HMC's discharged wastes give off a detectable odor of cyanide, which masks the odor of raw domestic sewage. Likewise, the tailings darken the streamflow to a leaden gray so the visual effect of the raw municipal waste is also disguised.

Implementation of domestic wastewater treatment is a necessity, especially in terms of protecting public health, restoring the aquatic environment, and helping to stimulate the local economy. Through the proposed project, these benefits can be gained without jeopardizing the environmental opportunities now characteristic of the Lead-Deadwood area. The area and surrounding environs are used for mining, forestry, recreation, tourism, wildlife habitat, and agriculture. Implementation of the project will not detract from these uses but rather will enhance the environmental value of the area, while not causing any regional shifts in population or changes in land use.

Chapter 5

IRREVERSIBLE AND IRRETRIEVABLE RESOURCE COMMITMENTS

The irreversible and irretrievable commitments associated with the proposed project involved capital, energy, mineral and water resources.

Construction and operation of the proposed sewage system will cost about \$7.8 million over the 20-year planning period. In order to finance the project, Lead and Deadwood will have to commit a majority of their available bond indebtedness to sewage treatment. The money set aside for this purpose can, therefore, not be used for other public improvements. Upon expiration of the functional life of the project, there will be some salvage value. For example, the land used for the plant can be sold, and most of the collection system and treatment plant structures will retain a value.

An irretrievable consumption of energy will result with the construction and operation of the project. Electricity and other energy forms will be consumed in the fabrication of construction materials such as concrete pipe, pumps, valves, asphalt and plant unit processes. Energy will also be consumed by the equipment used to construct the collection and treatment facilities. Finally, operation of the plant will require 2.4 million kWh of electrical energy per year for pump stations, in-plant pumps and other mechanical processes.

Mineral resources, primarily cement, sand, gravel and steel, will be consumed in the fabrication of reinforced concrete pipe, concrete cylinder pipe, pumps, tanks and unit processes. Approximately 28 tons of chlorine and 8 tons of sulfur dioxide per year will be required for effluent disinfection and dechlorination. A majority of the necessary resources needed for the project's development and operation will come from other areas, so there will be a net irreversible environmental effect on regions outside of the service area.

The lack of sewage treatment in Lead and Deadwood has committed Whitewood Creek as a waste transport corridor and has restricted other uses of the stream's water. Implementation of the proposed project will remove this commitment and thereby make available other uses of Whitewood Creek.

On the other hand, the commitment to use a mechanical treatment plant for wastewater management may occasionally result in depressed water quality and possible fish kills in Whitewood Creek. As discussed in earlier sections, the proposed plant is vulnerable to human error and to shock (toxic) influents, so plant failures, though infrequent, can be expected. Discharges of improperly treated sewage will impair water quality and possibly cause temporary odor.

As now planned, the proposed plant will not be able to accommodate the combined sewer flows in Lead during high runoff events. Thus, during many storms, the combined urban runoff and domestic sewage will be discharged to Gold Run Creek, a tributary to Whitewood Creek. The impact of bypassed combined wastewater on Whitewood Creek is not fully known at this time because chemical analyses of the water have not been made.

Last, the land used for the proposed treatment plant site will be committed throughout the duration of the project. This land can be reclaimed for other purposes after project amortization if so desired, so this commitment is not irreversible over the long term.

Chapter 6 ALTERNATIVE WASTEWATER MANAGEMENT SYSTEMS

Investigation of pollution problems in Whitewood Creek started in 1959; since that time roughly 50 scientific and engineering studies have been completed. The first section below, "Project History," summarizes the development of two original pollution abatement programs that were recommended prior to 1975. The following section then presents the results of the formal Facilities Plan study, which began in the fall of 1974. That section ends with a discussion of the recent South Dakota State Department of Environmental Protection (DEP) order modifying the required treatment level and the subsequent redirection of the Facilities Plan to develop a third round of alternative wastewater management systems. The rest of the chapter is an engineering, economic and environmental evaluation of the third round alternatives that were considered to be the most feasible in terms of the modified treatment requirements.

PROJECT HISTORY

The first engineering study was conducted in 1964 for HMC. This prefeasibility study concluded that use of a combined industrial tailings and domestic sewage lagoon would be the most feasible wastewater management system for the Lead-Deadwood area. The report recommended further study to verify this conclusion. In 1967 a pilot tailings and sewage lagoon was developed and analyzed. This pilot study recommended that the combined industrial and domestic wastewater treatment lagoon be located in Centennial Prairie.

Following the recommendation of the 1967 study, the equivalent of a Facilities Plan was published in 1971. Although various alternatives were evaluated, it was again concluded that a combined waste stabilization pond should be located at the Centennial Prairie site. The project cost was estimated at \$5.7 million. Subsequently, the engineering plans and cost estimates were revised to include lining the lagoon because of geological concerns about the site, especially the underlying Minnekahta limestone and gypsum.

In a March 1972 Environmental Impact Statement (EIS), the EPA endorsed the proposed Centennial Prairie lagoon system, stating that it was the most cost-effective and environmentally promising solution to pollution problems in Whitewood Creek. However, after the EPA ratified the project, concerns about its impact on ground water and area wells developed, and further geological investigations were made in June of 1973. These later investigations were not promising. At the same time, persons residing in the project area formed the Save

Centennial Valley Association with the motive to stop the project. This Association brought suit against the project which stopped its implementation. It was agreed that the District's sewage projects would not be located in or traverse Centennial Prairie.

Meanwhile, before the above suit was decided, a second major plan was developed in January 1974 because of the geological unknowns about the Centennial Prairie lagoon site. This plan included two separate treatment systems: Lead and HMC were to be serviced by a lagoon and land treatment system in Grizzly Gulch, and Deadwood's wastewater was to be impounded and used for irrigation water at Centennial Prairie.

An environmental assessment of this later plan was submitted to the EPA in March 1974. The EPA concluded that the assessment was not satisfactory. The agency's July 1974 critique stated that the plan did not evaluate a sufficient gamut of wastewater management alternatives and that the impact of the proposed Grizzly Gulch land treatment system had not been properly addressed. Also, it was EPA's impression that the Grizzly Gulch system would present severe environmental impacts. After EPA's evaluation and subsequent study by the District and their consultants, it was evident that this second wastewater management system was, like the Centennial Prairie lagoon plan, not implementable.

FACILITIES PLAN ALTERNATIVES

In August of 1975, after the EPA's rejection of the Grizzly Gulch wastewater management system, CH2M Hill was retained by the District to develop a formal Facilities Plan and an Environmental Assessment. The Facilities Plan study resulted in the development of three rounds of wastewater management alternatives, as discussed below.

FIRST AND SECOND ROUND ALTERNATIVES

By late 1975, CH2M Hill had developed 24 alternative management systems. To meet the NPDES Discharge Permit then in effect for Whitewood Creek, the alternatives had to provide the equivalent of advanced wastewater treatment (AWT). The Discharge Permit limitations were based on the State of South Dakota's classification of Whitewood Creek as a permanent cold water fishery.

A first round or preliminary evaluation was made of the 24 alternatives based principally on economic and legal considerations. This evaluation is documented in Chapter 5 of the Facilities Plan Technical Report. On the basis of this preliminary evaluation, the initial alternatives were pared down to three:

- Lower Deadwood Advanced Wastewater Treatment System

This system would treat the District's wastewater in an AWT plant located in lower Deadwood near the rodeo grounds. The plant would provide pretreatment, secondary and tertiary treatment, breakpoint chlorination, disinfection, dechlorination, and sludge handling and disposal facilities. The secondary unit processes would be an activated biological filter system (ABF) and secondary clarifiers. Mixed media filters would provide tertiary treatment with filter backwash storage and treatment facilities. The sludge would be aerobically digested and thickened before disposal in the planned HMC tailings pond.

- Lower Deadwood Secondary Treatment System

In the Lower Deadwood Secondary Treatment System, the District's wastes would be treated in a secondary treatment plant in lower Deadwood. Facilities in the secondary treatment plant would be similar to those for the AWT plant up through the secondary processes plus the effluent disinfection unit and sludge handling and disposal facilities. This system would not provide any tertiary treatment breakpoint chlorination, or dechlorination.

- Grizzly Gulch Land-based Treatment System

A land-based system located in the Grizzly Gulch area would be used to treat the combined industrial and municipal flows. The land-based treatment facilities would include a tailings dam, tailings-wastewater storage reservoir, transmission pipeline, and distribution and irrigation systems. The District's wastewater would be delivered above the tailings dam. HMC's tailings would be delivered through a separate pipeline and would also be deposited above the dam. During the winter the combined wastewater would be stored in the tailings-wastewater storage reservoir. During the summer the wastewater would be pumped to an irrigation site above the reservoir, between Yellow and Whitewood Creeks. A sprinkler irrigation system would distribute the wastewater over the irrigation area. As the wastewater moves through the vegetation and the soil and rock profile, it would be treated by filtration, oxidation, crop uptake, adsorption, precipitation, denitrification and ion exchange.

These three alternatives were given a more detailed or second round competitive evaluation for their engineering, economic

and environmental feasibility. The Lower Deadwood Secondary System, which would not meet the discharge standards, was included to provide a benchmark from which to measure the costs and benefits of the two more advanced systems. This evaluation is presented in Chapter 7 of the Technical Report.

The alternative that appeared to be the most feasible was the Lower Deadwood AWT System. However, all three of the systems were considered unacceptable by the District because of the following reasons:

1. The alternatives would be too costly and would therefore not be approved by the District's residents.
2. All the less costly alternatives involved a lower treatment that would not meet the required effluent limitations. Furthermore, it was questioned whether implementing the treatment level required to meet the effluent limitations would assure the establishment of a cold water fishery in Whitewood Creek because of uncertainties associated with the stream's hydrological data and the unknown effects of the existing tailings deposits.
3. Construction of a wastewater treatment facility in lower Deadwood would be unacceptable due to visual and odor problems characteristic of conventionally designed wastewater treatment facilities.

Following the second round alternatives evaluation, a draft Facilities Plan report was completed in July 1975 to present the study findings and the selected system. The draft also noted the above concerns about the ability to implement the AWT plant or any system that would meet the required effluent limitations. To alleviate these concerns, the draft report considered the investigation of compromise solutions. These compromise solutions would have lower costs but would not meet the set effluent limitations. Implementation of any compromise alternative would require modifying the permanent cold water fishery objective.

THIRD ROUND ALTERNATIVES

On the basis of the information in the draft Facilities Plan, the District sought to get the effluent limitations lowered. Two legal actions resulted. First, the State of South Dakota changed the stream classification of Whitewood Creek below Deadwood from a permanent to a marginal cold water fishery. Second, on 5 March 1976, the State DEP issued an order that waived the water quality objective to allow secondary treatment of the District's wastes with the provision for upgrading the treatment system by 1 July 1988 to meet the cold water fishery

objective if future evidence shows that Whitewood Creek will rehabilitate itself by that date.

This order made possible the consideration of lower level treatment alternatives. As a result a third round of two alternatives was developed. A new alternative was introduced called the Grizzly Gulch Lagoon System. The other alternative is the proposed lower Deadwood secondary treatment plant, which was originally a second round alternative. This system has been modified to meet the concerns about visual and odor problems by providing dechlorination and effluent aeration facilities, housing the entire plant in a building, and including odor control equipment to cleanse any odors originating from the treatment facility.

Costs were reduced by revising the collection system to serve fewer households than would have been served under the collection system proposed for the first and second round alternatives. Specifically, planned service to the outlying areas of Terraville, Deer Mountain, Terry Peak/Bald Mountain, and Nevada Gulch/Fantail was eliminated because of the high cost associated with serving a proportionately small number of homes.

The Lower Deadwood Secondary System (LDSS), which is the proposed project, has already been described in Chapter 1. An overview of the Grizzly Gulch Lagoon System (GGLS) is given on Figure 6.1. The GGLS involves the collection and transport of the District's wastewater to an aerated lagoon and winter storage reservoir in Grizzly Gulch. Effluent from the system would be discharged into Grizzly Creek and would reach Whitewood Creek just above Pluma. Treatment of the District's wastewater would be provided by a 2- to 4-day detention time aerated lagoon located in a side branch of Grizzly Gulch and the 200-day detention time winter storage reservoir located on the main stem of Grizzly Gulch. Effluent disinfection and dechlorination facilities would be provided, although it is not anticipated that operation of these facilities would be needed to achieve the bacterial standards. Sludge handling facilities would not be required.

The GGLS is designed to be expanded and upgraded in a series of steps or phases. A storm collection system and holding pond located in Cub Gulch below Lead could be added at a later date. Capacity in the storage reservoir would be sized to handle the average yearly storm water runoff from the Lead area. Although this system would not be implemented immediately, space would be provided in the Pluma pump station for the addition of more pumping capacity. Another modification could be the addition of other unit processes, both upstream and downstream of the presently planned reservoir system. The dam would be located in such a manner as to provide enough head to lift the waste via an inverted syphon through Deadwood to the

Mountain Meadow areas for possible future land treatment. Other land treatment sites above the City of Deadwood and possibly in the Grizzly Gulch vicinity could be utilized with a minimal amount of pumping.

The engineering, economic and environmental evaluation of these two alternatives is presented below. For both alternatives it is assumed HMC will provide their own treatment of process water and tailings material. This treatment will consist of a large tailings dam to be constructed in the upper reaches of Grizzly Gulch above the existing airshaft. Decant water from the tailings pond will be recycled back to the ore processing facilities in Lead and used as sluice water to transport tailings to Grizzly Gulch. Process water from the HMC mill will be treated using a chemical precipitation-filtration system and either reused or discharged to Gold Run Creek. Because the HMC NPDES Discharge Permit imposes extremely high effluent standards, it is anticipated HMC will not discharge but reuse the treated water.

ENGINEERING ASSESSMENT

PROJECT COST

A comparative cost summary of the two alternatives is presented on Table 6.1. The range in the cost estimates for the GGLS is due to uncertainty about the construction of the dams and diversion ditch.

Grizzly Gulch Lagoon System

The GGLS has a higher capital and grant requirement and a lower operating cost than does the LDSS. The estimated household monthly cost could be approximately the same as that for the LDSS. The monthly cost could range from a low of \$6.40 per month to a high of \$13.20, depending on the project's actual cost. This cost range overlaps the range given below for the LDSS estimated monthly cost.

The expected life of the GGLS is significantly longer than for the LDSS. The storage reservoir dam and diversion ditch have an expected life of 100 years, as reflected in the present worth analysis. The present worth is estimated to be \$10,833,000, which is significantly higher than that for the LDSS. A detailed cost summary for the GGLS is given on Table 6.2.

Lower Deadwood Secondary System

The LDSS has a lower present worth, capital cost, and grant requirement. The LDSS has approximately the same annual cost as the GGLS. The annual operating cost for the LDSS is higher than for the GGLS. The estimated monthly household

Table 6.1

COMPARATIVE COST SUMMARY

	<u>Grizzly Gulch Lagoon System</u>	<u>Lower Deadwood Secondary System</u>
Capital Cost		
Collection System	\$3,149,000	\$1,585,000
Flow Reduction	109,000	109,000
Wastewater Treatment	4,226,000 - 5,704,000	2,630,000
Sludge Disposal	-	360,000
Total Construction Cost	7,484,000 - 8,962,000	4,684,000
Eng., Legal, etc., costs (15%)	1,123,000 - 1,344,000	703,000
Total Project Cost	8,607,000 - 10,306,000	5,387,000
Federal Grant (75%)	6,455,000 - 7,730,000	4,040,000
State Grant (2.5%)	215,000 - 258,000	135,000
Local Cost	1,937,000 - 2,318,000	1,212,000
Operation and Maintenance Cost (annual)		
Collection System	55,000	23,000
Flow Reduction	5,000	5,000
Wastewater Treatment	87,000	162,000
Sludge Disposal	-	42,000
Total O&M Cost	147,000	232,000
Capital Recovery	183,000 - 219,000	114,000
Total Annual Cost	330,000 - 366,000	346,000
Estimated Monthly Household Cost	9.17 - 10.14	9.61
Present Worth	9,428,000 - 10,833,000	7,845,000

Table 6.2

SUMMARY OF GRIZZLY GULCH LAGOON SYSTEM
PROJECT COST

	<u>Construction</u>	<u>Operation and Maintenance (annual)</u>
Collection System		
South Lead	\$ 312,000	\$10,000
Pluma	50,000	1,000
Grizzly Gulch	75,000	1,000
Gold Run	42,000	1,000
Deadwood Creek System	428,000	4,000
Deadwood	175,000	2,000
North Washington Street	55,000	1,000
Deadwood Pump Station	245,000	12,000
Force Main to Pluma		
P/S	540,000	5,000
Lead Pump Station	309,000	5,000
Force Main to Grizzly		
Gulch	411,000	4,000
Pluma Pump Station	287,000	7,000
Force Main to Grizzly		
Gulch	<u>220,000</u>	<u>2,000</u>
Subtotal	3,149,000	55,000
Flow Reduction	109,000	5,000
Wastewater Treatment		
Aeration Pond	212,000 - 268,000	-
Aeration Equipment	280,000	30,000
Dam and Reservoir	3,500,000 - 4,795,000	35,000
Diversion Ditch	20,000 - 147,000	2,000
Disinfection	110,000	-
Dechlorination	54,000	-
Lab, Shop, & Admin.		
Bldg.	50,000	20,000
Sludge Disposal	-	-

cost for the LDSS could range from \$6.73 to \$12.49. Detailed cost summaries are presented on Tables 6.3 and 6.4.

No Action Alternative

Although this system imposes no capital or operation and maintenance costs on the residents of Lead and Deadwood, it does have negative fiscal impacts there. These costs are discussed in the environmental evaluation later in this chapter.

EFFLUENT QUALITY

Grizzly Gulch Lagoon System

A precise prediction of the GGLS performance cannot be accurately determined with present information. However, some general statements can be made.

- The effluent from the pond should have a BOD and (possibly) suspended solids level below 30 mg/l. Increased BOD and suspended solids removal may be possible with proper operation and the use of multiple discharge levels in the reservoir.
- Nitrification and denitrification would occur in the storage reservoir. The amount of $\text{NH}_3\text{-N}$ reduction cannot be precisely estimated, but the effluent should have a $\text{NH}_3\text{-N}$ concentration of around 3 to 5 mg/l. Indian Creek Reservoir in California has an influent $\text{NH}_3\text{-N}$ concentration of >15 mg/l and an effluent of 4 mg/l. The change is due to nitrification-denitrification.
- Effluent disinfection and dechlorination equipment would be provided; however, it is not expected to be used. The die-off rate for most pathogens is usually much shorter than the 200-day average detention time that would be provided by the reservoir. Should disinfection be required, the chlorination and dechlorination equipment could be used.
- The effluent dissolved oxygen level could vary, depending on the method of operation. Aeration provided by Grizzly Creek should allow dissolved oxygen levels in the effluent to be near the oxygen saturation value before it reaches Whitewood Creek.
- The dissolved nitrogen level could be high enough to interfere with fish life, depending on the method of operation. Aeration and mixing provided by Grizzly Creek should significantly reduce the danger to fish life in Whitewood Creek.

Table 6.3

SUMMARY OF MODIFIED LOWER DEADWOOD SECONDARY SYSTEM
PROJECT COST

Collection System	<u>Construction</u>	<u>Operation and Maintenance (annual)</u>
South Lead	\$ 312,000	\$ 10,000
Pluma	50,000	1,000
Grizzly Gulch	75,000	1,000
Gold Run	120,000	1,000
Deadwood Creek System	428,000	4,000
Deadwood	55,000	1,000
North Washington Street	55,000	1,000
Lower Whitewood	150,000	1,000
Deadwood Interceptor	<u>340,000</u>	<u>3,000</u>
Subtotal	1,585,000	23,000
Flow Reduction in Lead	109,000	5,000
Treatment Plant	2,630,000	162,000
Sludge Disposal	360,000	42,000

Table 6.4

COST SUMMARY FOR LOWER DEADWOOD
SECONDARY TREATMENT PLANT

<u>Unit Process</u>	<u>Construction</u>	<u>Operation and Maintenance (annual)</u>
Pretreatment (Screening)	\$ 98,000	\$ 4,000
Redwood Fixed-film Tower	269,000	15,000
Supplementary Aeration	450,000	28,500
Recycle Pump Station	221,000	15,200
Secondary Clarifiers	179,000	9,000
Disinfection	125,000	14,100
Dechlorination	61,000	9,000
Yard Work	180,000	2,500
Laboratory & Administration	168,000	37,700
Plant Housing & Shop	750,000	10,000
Odor Control	<u>129,000</u>	<u>17,000</u>
TOTAL	2,630,000	162,000

Lower Deadwood Secondary System

The secondary treatment plant would produce an effluent with BOD and suspended solids values below 30 mg/l. The ammonia-nitrogen level should be below 3 mg/l. Disinfection with chlorine followed by dechlorination and reaeration should meet the bacterial, total residual chlorine and dissolved oxygen standards.

No Action Alternative

Without treatment raw sewage would continue to be discharged to Whitewood Creek and its tributaries.

RELIABILITY

Grizzly Gulch Lagoon System

In comparison to a mechanical treatment plant, the GGLS offers greater reliability. The system uses natural biological processes to oxidize pollutants with little or no need for skilled operators. Consequently, the potential for human error is minimal. In contrast to biological treatment plants, a lagoon system such as the GGLS is resistant to shock loadings of toxic effluents.

It should be noted that improper management of the lagoon system could result in reduced removal efficiencies. It would take a long time to correct possible problems due to the extensive hydraulic detention time of the system.

Lower Deadwood Secondary System

The LDSS should be highly reliable given proper operation and maintenance. However, the system does require substantial attention by operators, so the element of human error exists. Without properly trained plant personnel, the system would not provide satisfactory waste removal. Housing the treatment plant inside a building increases the plant reliability because the biological treatment processes will be partially protected from severe cold weather conditions. The efficiencies of biological processes tend to be reduced at low temperatures.

No Action Alternative

Discussion not applicable.

FLEXIBILITY

Grizzly Gulch Lagoon System

The GGLS has a wide range of alternatives to provide better than secondary treatment. First, unit processes could be added either upstream or downstream of the lagoon. Although the additional units would not necessarily have to be contained in Grizzly Gulch, suitable land for this purpose is available in the gulch. Second, higher levels of treatment could be accomplished by land disposal of the lagoon effluent. Several land application sites are available and appear economically feasible for waste treatment development. It is expected that a properly designed land disposal system would provide better than tertiary treatment.

In addition, the GGLS could be readily converted to include partial storm water treatment. Storm water from the Lead collection system could be diverted to Cub Gulch, a small gulch north of Lead, for settling and subsequent transmission to Grizzly Gulch for treatment.

One possible problem presented with the lagoon system is that expansion for additional treatment capacity could not be achieved without costly modification. Enlargement of the reservoir dam and the lagoon would be required.

Lower Deadwood Secondary System

This system affords about the same opportunity for providing higher levels of treatment as does the GGLS. The LDSS has been predesigned to facilitate the addition of AWT processes. Tertiary unit processes could be added to the secondary treatment plant or the secondary effluent could be conveyed to another area for land disposal. Although suitable land disposal sites have been identified, the feasibility of land disposal versus the addition of tertiary unit processes is not known. As opposed to the GGLS, addition of land disposal to the LDSS could require development of a winter storage lagoon.

One major advantage of the LDSS is that the system could be easily expanded to provide additional treatment capacity. This would be more difficult for the GGLS. (Capacity refers to the population equivalent serviced by the facility.)

No Action Alternative

Discussion not applicable.

RESOURCE/CHEMICAL COMMITMENT

Grizzly Gulch Lagoon System

The total energy requirement for operation of the component pump stations and the lagoon aerator has been estimated at 1.8 million kWh per year. Chemicals for disinfection would probably not be required for this system due to the high removal of pathogens during the 7-month detention time, although disinfection equipment would be provided.

Lower Deadwood Secondary System

Operation of pumps and other mechanical equipment that is part of the LDSS would require approximately 2.4 million kWh per year. The process would have an annual commitment of chlorine and sulfur dioxide for effluent disinfection and dechlorination, respectively. In addition, small quantities of odor control chemicals and polymer for flotation thickening are needed.

No Action Alternative

Continuation of no action would not involve consumption of fossil fuels, but it would involve the continued degradation of Whitewood Creek. Severe pollution of this creek precludes the use of its water resource for other useful purposes (domestic, agricultural, wildlife, etc.).

LAND REQUIREMENTS

Grizzly Gulch Lagoon System

The GGLS would require approximately 100 acres of land for the dam and storage reservoir. In addition, the three major pump stations would each require a commitment of approximately one-half acre. The three small pump stations bordering south Lead would have inconsequential site requirements.

Lower Deadwood Secondary System

This system would require approximately 2.5 to 4 acres.

No Action Alternative

No land in the service area would be committed for waste treatment.

IMPLEMENTATION

Grizzly Gulch Lagoon System

Construction of this system could begin in late 1977, and operation could start in the winter of 1978 or the spring of 1979.

Two major tasks must be achieved to implement the GGLS. First, revisions in Whitewood Creek stream standards changing the creek's status from a cold water permanent fishery to a cold water marginal fishery at the northern border of Deadwood's city limits would have to be extended upstream to the confluence of Whitewood and Grizzly Creeks. Second, construction of the proposed dam would require acquisition of at least two and possibly 12 homesites, depending on additional information. In addition, approximately 5.0 acres would have to be acquired from the Bureau of Land Management. The combination of these factors could prolong project implementation.

Lower Deadwood Secondary System

The construction of this system could also be initiated in 1977; the plant could be online by the autumn of 1979. However, development of the plant in lower Deadwood could result in possible land use conflicts with the State of South Dakota, which could lengthen the implementation schedule. However, it is expected that of the two systems, the LDSS would be easier to implement.

No Action Alternative

Due to health hazards and promulgated State and Federal legislation, the no action alternative would not be possible. Failure to provide treatment could subject the District to daily fines of up to \$25,000 per day.

ENVIRONMENTAL ASSESSMENT

This section presents a comparison of the construction impacts as well as the long-range operational impacts of the two most promising wastewater management systems for the Lead-Deadwood area. Because both of the proposed systems would not involve HMC wastewater management, the actions taken by HMC for pollution abatement are not assessed here.

The collection systems for the two alternatives are nearly identical. Therefore, the collection system impacts are not considered in this evaluation, because they would provide no basis for comparison. A detailed investigation of the effects of installing a sewerage system in the Lead-Deadwood service area is presented in Chapter 3.

SOIL, GEOLOGY AND AIR QUALITY

Grizzly Gulch Lagoon System

The development of the dam, lagoon and access roads would constitute a major earth movement project. Vegetation and topsoil would be removed, exposing soil to erosion. Erosion would be prolonged by constant movement of large construction machinery. The principal impact would occur in the lower reach of Grizzly Gulch, where over 100 acres would be affected. Material for the proposed dam could be quarried from the lagoon site, so erosion and earth movement impacts would be restricted to the local area.

In addition, excavation, blasting, the movement of large machinery and increased traffic would impact local air quality and increase noise. Dust fallout would be the most significant air quality impact, but emissions from internal combustion engines would also have an influence. Dust and noise impacts would be severe and may justify relocation of the 20 homes located at the mouth of Grizzly Gulch.

Lower Deadwood Secondary System

The processes required for the development of the treatment plant--site preparation, excavation, movement of large equipment and materials, etc.--would expose the site to erosion and cause a local increase in dust. About 2.5 acres of soil surface would be affected. Erosion impacts are not expected to be serious due to the near level topography of the site. Dust fallout impacts would be minimal.

In addition, preparation of the site would require importation of approximately 18,000 cubic yards of fill material. Extraction of this material would obviously impact the borrow area; however, assessment of this effect is not presently possible because a borrow area has not been identified. It is also assumed no unusual soil or foundation conditions exist on the plant site.

No Action Alternative

The decision to not provide sewage treatment in the Lead-Deadwood area would avoid the potential for erosion and dust impacts that would accompany the development of either of the two proposed alternatives.

WATER QUALITY

Grizzly Gulch Lagoon System

Development of the lagoon system would result in demonstrable improvements in water quality in local creeks. With effective management the system would produce secondary effluent, thereby fulfilling stream standards. It should also be recognized that the effluent does not have to be discharged during low streamflow conditions but can be released during high periods of runoff when the most favorable dilution ratios are available. Consequently, the system could conceivably be managed to permit establishment of a cold water fishery. The ability to establish a fishery is currently unknown due to the uncertain effects of existing tailings deposits and stream characteristics. Assessment of the stream's capability to recover and support a fishery can only be made after cleanup programs are underway.

In contrast, the construction process would have some unfavorable impacts on water quality. Development of the lagoon and dam would cause substantial turbidity in Grizzly Creek, which discharges to a relatively unpolluted segment of Whitewood Creek (between the confluence with Grizzly Creek and Pluma). Consequently, water quality in this reach of Whitewood Creek would be impaired during project construction.

Lower Deadwood Secondary System

Similar to the lagoon system, the development of a treatment plant at lower Deadwood would be marked by improved water quality in area creeks. Because it would be located at lower Deadwood, development of the plant would result in no discharge of municipal effluent in the reaches of creeks which flow through Lead and Deadwood. All discharges would be released below Deadwood. During low flow conditions, this lower Deadwood discharge point would be an advantage both aesthetically and possibly from a public health standpoint.

On the other hand, the treatment plant is subject to failure from shock loads or from human operational error. Although such failures are anticipated to be infrequent, depressed water quality conditions in Whitewood Creek would be unavoidable.

Second, the system's nitrification efficiency could decrease during cold weather, causing excessive discharges of ammonia and reduced water quality. Also, the ability of an upset nitrification system to recover during cold weather is poor. Thus, extended periods of high ammonia levels in the effluent could result. The treatment facility is designed for cold weather nitrification and the plant will be enclosed in a building, so no major problems are expected.

Although construction of the plant would be adjacent to Whitewood Creek and may require rerouting of small rivulets which run through the site, serious water quality disturbances would not occur. Water quality in Whitewood Creek is presently low enough so that additional turbidity caused by plant construction would not be noticeable.

No Action Alternative

Maintenance of existing practices would result in continued degradation of Gold Run, Whitetail, Deadwood, and Whitewood Creeks, the Belle Fourche and Cheyenne Rivers, and Oahe Reservoir. Consequently, the promulgated stream standards for Whitewood Creek and its tributaries would be violated.

HYDROLOGY

Grizzly Gulch Lagoon System

The impact of this system on hydrology is, in part, dependent on operation. Collection of Lead's waste and conveyance to Grizzly Gulch would reduce flow in Gold Run Creek by about 2.3 cfs. Discharge from the lagoon to Grizzly Creek would have little effect on streamflow during high streamflow periods or could have a marked effect on flow if the effluent were released during low flow periods. If the effluent from the lagoon is high quality, releases during late summer low flow periods could be used for streamflow augmentation. Cold water fish cannot survive in the equivalent of secondary effluent, however.

Lower Deadwood Secondary System

Placement of a plant at lower Deadwood would require that domestic wastewater which is presently discharged to Gold Run Creek (which in turn discharges to Whitewood Creek) be collected and conveyed to the prospective plant site in lower Deadwood. Consequently, as with the GGLS, Gold Run Creek and the reach of Whitewood Creek between Pluma and lower Deadwood would lose 2.3 cfs of streamflow. Low flow in Whitewood Creek, which has been estimated at 6.0 cfs by the EPA, would be reduced to less than 4.0 cfs.

The LDSS does not provide the potential for low flow water augmentation that would be afforded with development of the GGLS.

No Action Alternative

Even if the District did not provide sewerage service, flow in Whitewood Creek would be reduced by 7 cfs as a result of HMC water reuse and (tentative) zero discharge system. However,

if a plant is not built in lower Deadwood, the 2.3 cfs that would be conveyed there by pipe from Lead would remain in the reach of stream between the two cities.

VEGETATION AND WILDLIFE

Grizzly Gulch Lagoon System

As mentioned previously, development of this system would result in marked improvements in the water quality of area streams. Due to extant tailings deposits and the physical features (steep gradient, lack of pools, etc.) of Whitewood Creek, the potential for developing a marginal cold water fishery is uncertain. However, with improved conditions in Whitewood Creek, the reestablishment of many aquatic and semi-aquatic species is expected. Improvements in the water environment would also increase the suitability of the Whitewood Creek corridor for semi-aquatic and terrestrial birds and mammals. The establishment of aquatic life in the creek would supplement the local food chain, benefiting such animals as raccoon, muskrat, water fowl and shore birds.

The construction of the lagoon system would result in the loss of 100 acres of forest land near the mouth of Grizzly Creek. In addition, the Grizzly Creek ecosystem would be adversely affected by project development. Wildlife species, both terrestrial and aquatic, which are currently found on the prospective site would be displaced and probably die. Most of the affected species would be small mammals, principally rodents. No rare or endangered species have been identified onsite.

Lower Deadwood Secondary System

The environmental advantages of adopting this alternative are nearly analogous to the benefits described above for the GGLS. However, some minor differences are apparent.

First, the location of the secondary treatment plant would be at lower Deadwood, so no municipal effluents would be discharged to Whitewood Creek in the reach through Deadwood. This would aid in establishing a fishery in this segment of stream, especially during low flow periods. (It should be recalled that the GGLS could be managed to avoid effluent discharges during low streamflows when dilution ratios are unfavorable.)

Second, as described previously, the treatment plant is subject to failure, either through accidents or mismanagement. If a plant upset occurred, fish kills could result, especially during late summer when streamflow is low. Likewise, loss of nitrification could cause fish kills.

Development of the LDSS would have only minor impacts on vegetation and wildlife. The prospective site is used for storage of wrecked automobiles and oil and as an overflow parking lot for the nearby rodeo grounds. The construction process would affect about 4.0 acres, resulting in the destruction of little or no wildlife habitat.

No Action Alternative

The no action alternative would avoid the construction impacts accompanying the two action alternatives. However, under the no action alternative the area streams would remain polluted, thus eliminating the benefits to wildlife that would be provided by the action alternatives.

Failure to provide sewage treatment in the Lead-Deadwood area would not affect vegetation. But aquatic life in the involved streams would remain suppressed. Whitewood Creek would continue to support little biological life, and the biological productivity of the Belle Fourche and Cheyenne Rivers would remain impaired.

SENSORY IMPACTS--AESTHETICS, ODOR AND NOISE

Grizzly Gulch Lagoon System

The visual and odor problems characteristic of a community without effective sewage treatment would be corrected with development of this alternative. The streams that run through Lead and Deadwood would run clear and free of odor and the presently surcharged Imhoff tanks in Lead could be abandoned.

In contrast to the community benefits realized by developing this alternative, some localized problems are expected. The construction of a 150-foot dam across Grizzly Gulch would increase local dust and noise during development and would markedly affect the aesthetics of the gulch area after the dam was installed. In addition, the lagoon is anticipated to be odorous during spring and fall pond turnovers and possibly during other phases of operation. Because the prospective site is relatively remote, only about 15 to 20 homesites would be impacted. However, it is possible that some of these homeowners may be relocated to minimize potential problems.

Lower Deadwood Secondary System

Like the previous system discussed, development of the LDSS would improve stream aesthetics and reduce local odor problems arising from inadequate sewage treatment facilities. An advantage of this system is that all sewage effluents would be discharged from lower Deadwood.

The system also has some disadvantages. During project construction, noise and vehicular congestion would be increased at lower Deadwood. The plant installation would represent a conspicuous visual change in lower Deadwood and could be readily observed from U.S. Route 85, which provides major entrance and exit to the Lead-Deadwood area. Housing the plant in a building, however, should lessen the visual impact of the plant. No odor impacts should be associated with the plant's operation, because an odor control system would be provided.

No Action Alternative

A no action approach to wastewater management in the Lead-Deadwood area would have negative as well as positive impacts on the sensory environment.

Negative impacts would include continuation of odors along Whitewood Creek and reduced stream aesthetics due to severe pollution. Positive impacts would include avoidance of the construction disturbances accompanying both treatment alternatives and the preservation of Grizzly Gulch as a pristine landscape.

LAND USE AND DEVELOPMENT

Grizzly Gulch Lagoon System

Like all of the alternatives devised for the management of wastewater in the Lead-Deadwood service area, the GGLS has been sized after analysis of the best available population data. All alternatives have been formulated to provide about 5-percent additional capacity by the end of the 20-year planning period. Unless unpredicted industrial development occurs in the area, supplementing the employment base, the population in Lead and Deadwood is expected to remain relatively stable. Consequently, provision of sewerage service would not, in itself, stimulate unplanned growth. In contrast, development of a sewerage system would provide stimulus to the local economy, as discussed in the next section on socioeconomic impacts.

The prospective lagoon site is privately owned and is about 0.25 mile upstream of a small community of about 15 to 20 homes. At present, acquisition of at least two homes would be necessary to build the lagoon, so a certain amount of land use conflict may result. As expressed previously, the noise, dust and other inconveniences during project construction may be severe enough to merit relocation of the affected 12 homesites. Proximity of the residences to a large sewage impoundment may also result in conflict. Landscaping, public relations, or outright purchase of the involved homes are possibilities for minimizing possible conflicts.

Lower Deadwood Secondary System

Development of this system is not anticipated to encourage unplanned population influx for the same reasons discussed above for the GGLS.

The lower Deadwood site is zoned for future industrial use. Although this zoning appears consistent with development of a secondary treatment plant, land use conflicts are possible.

Because developable sites are scarce in the Lead-Deadwood area, use of the lower Deadwood site for sewage treatment has been met with some resistance. Because other areas, such as Grizzly Gulch, are available for wastewater facilities, many citizens feel that the lower Deadwood site could be used for some other purpose.

An objection to the LDSS is that the lower Deadwood site is adjacent to the rodeo grounds and is used for additional parking capacity during special events. Development of the plant on the proposed site could cause minor parking problems during rodeo events.

Last, the South Dakota Department of Highways owns the right-of-way through a portion of the lower Deadwood site, so acquisition conflicts between the District and the State are possible.

No Action Alternative

Although neither of the above alternatives is expected to entice new development, adoption of a do nothing policy could cause a loss of population as well as prevent new development. Without sewage treatment, a community is not eligible for FHA assistance loans. As discussed in the next section of this chapter, this ineligibility has and would continue to have a substantial effect on the availability of housing in the Lead-Deadwood area.

SOCIOECONOMIC IMPACTS

Grizzly Gulch Lagoon System

The principal advantage of providing sewerage facilities in the Lead-Deadwood area would be the protection of public health and water resources both locally and regionally. Raw sewage contains viruses and pathogens that can be injurious to public health. At present Gold Run and Whitewood Creeks function as open sewers; other smaller creeks are also polluted by raw or partially treated sewage. Consequently, contamination of private wells, which has been documented in Nevada Gulch, and public exposure to pathogens present a health hazard, both in Lead and Deadwood and communities downstream.

Second, the provision of sewage treatment would add to the desirability and economic value of real estate in the service area. In addition, installation of a federally acceptable sewage treatment system would qualify Lead and Deadwood for FHA assistance loans to help alleviate their housing shortage. Reportedly, 30 percent of the dwelling units in the area are "substandard." Consequently, about 1,000 people have moved from the District to surrounding communities--Sturgis, Spearfish and Whitewood--during the past 5 years. Provision of the sewage system is anticipated to benefit the local economy.

The sewage impoundment would be built about 0.25 mile upstream of a small cluster of homes. Consequently, there may be some concern about possible dam failure. Although dam failure is a statistical possibility, the chances of failure are very small.

The GGLS is devised to discharge effluent to Grizzly Creek. After development of the lagoon system, the creek flow would be nearly 100 percent effluent. The creek runs through the backyards of approximately a dozen homes; therefore, parents might be concerned about children or pets coming in contact with the treated water. The wastewater would be treated to comply with immersion contact stream standards, so conflicts between human activities and use of Grizzly Creek for effluent discharge are not expected.

Lower Deadwood Secondary System

The general public health and economic advantages described above are also applicable to this system.

The principal advantage offered by this alternate is that treated effluent would be discharged below Deadwood. Consequently, public contact with wastewater would be less probable than with implementation of the GGLS. A second advantage of this system is that it avoids the possible, albeit minute, danger associated with the dam construction in the GGLS.

The most apparent disadvantage of this system is the possible reluctance of local citizens to approve development of a treatment plant at lower Deadwood. The District Board members, however, are of the opinion that enclosing the plant within a building and providing odor control equipment will make the plant acceptable to the citizens.

No Action Alternative

The only advantage of the no action alternative realized by local citizens would be the avoidance of increased costs (from nothing up to \$10 per month) for sewage collection and treatment. Although this benefit appears significant, in reality it is

small when compared to the socioeconomic costs of no sewage collection and treatment.

Persistence of public health hazards and continued environmental degradation are major disadvantages of no action. Because several of the area's creeks function as open sewers, human contact with injurious pathogens represents a potential health hazard. In addition, the odors and visual disamenities accompanying the degraded condition of Whitewood Creek would persist with the no action alternative. The impact of the creek's unsightly condition on local community pride and on the tourist industry is difficult to measure.

The choice to provide no sewage treatment also has adverse economic impacts because the communities would remain ineligible for FHA and HUD housing loans.

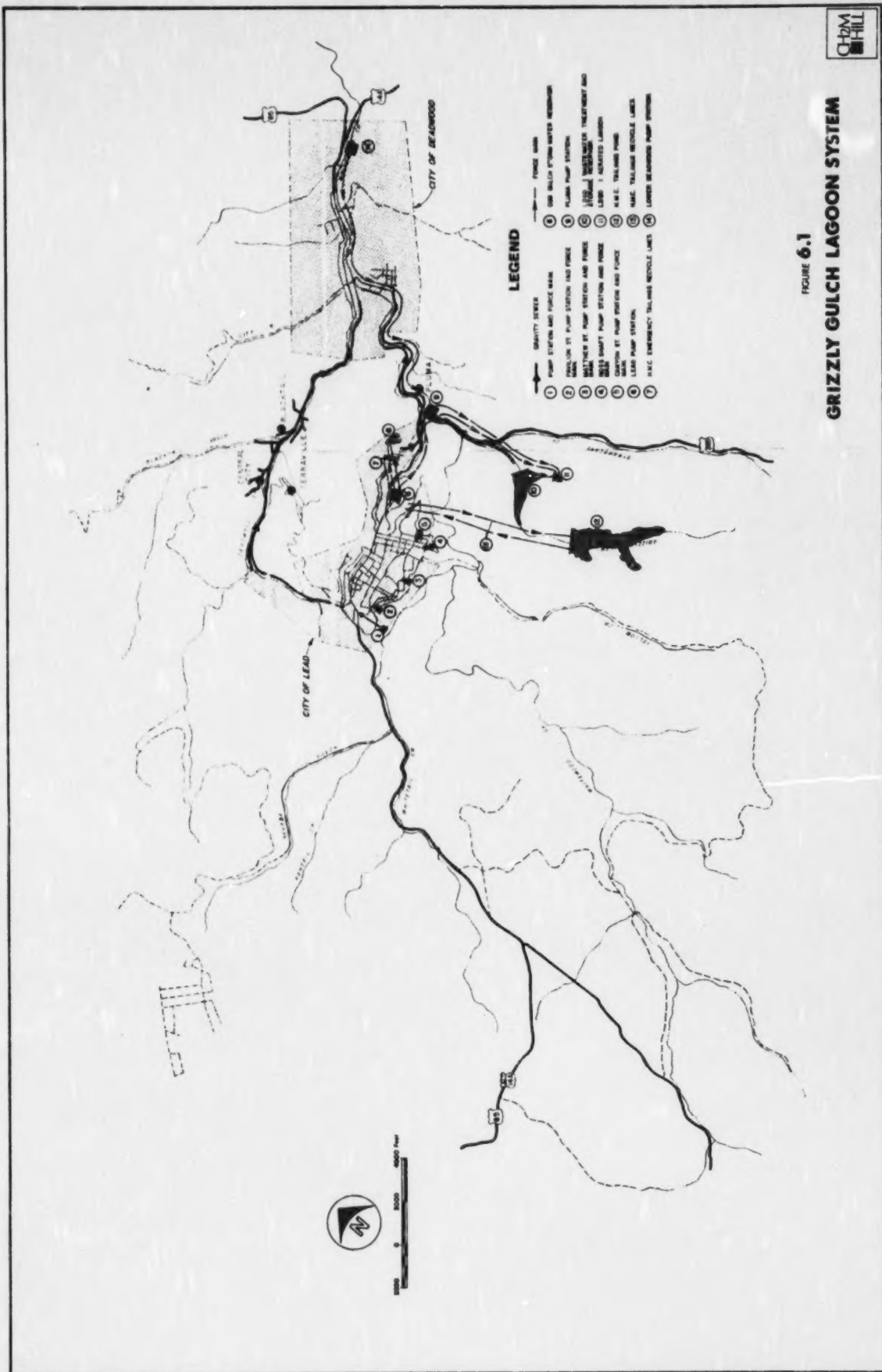


Table A.1

PLANT SPECIES OBSERVED IN THE LEAD-DEADWOOD AREA

<u>Common Name</u>	<u>Scientific Name</u>	<u>Exposure of Location</u>
Ponderosa Pine	<u>Pinus ponderosa</u>	North- and south-facing slopes
White Spruce	<u>Picea glauca albertiana</u>	Low level on the south-facing slopes, streambank, mixed on north-facing slopes
Paper Birch	<u>Betula papyrifera</u>	Moist places on south-facing slopes, mixed on north-facing slopes
Quaking Aspen	<u>Populus tremuloides</u>	Moist places on south-facing slopes, mixed on north-facing slopes
Oregon Grape	<u>Berberis repens</u>	Mostly on the north-facing slope
Juniper	<u>Juniperus sibirica</u>	On both north- and south-facing slopes
Oak	<u>Quercus macrocarpa</u>	
Kinnikinnick	<u>Arctostaphylos uva-ursi</u>	Gradual slopes on the south-facing slope, fairly uniform on the north-facing slopes
Snowbrush	<u>Ceanothus</u> sp.	Where moderate slopes occur
Pyrola	<u>Pyrola</u> sp.	North-facing slopes
Orchid	<u>Corollorhiza</u> sp.	North-facing slopes
Pine Droops	<u>Pterospora</u> sp.	North- and south-facing slopes
Purple Clover	<u>Trifolium</u> sp.	Along roads
Pearly Everlasting	<u>Anaphalis margaritacea</u>	Along roads
Purple Daisy	<u>Aster</u> sp.	In clearings
Sedges	<u>Carex</u> sp.	In clearings
Goldenrod	<u>Salidago</u> sp.	Along road and clearings
Strawberry	<u>Fragaria</u> sp.	Along roads in open areas
False Aster	<u>Boltonia latisquama</u>	
Shepherd's Purse	<u>Capsella bursa-pastoris</u>	Clear areas
Plantain	<u>Plantago</u> sp.	Clear areas
Snowberry	<u>Symphoricarpos</u> sp.	Near beaver ponds, near water
Willow	<u>Salix</u> sp.	Along streambanks
Bur Oak	<u>Quercus macrocarpa</u>	Along slopes leading from streambeds
Cottonwood	<u>Populus</u> sp.	Along streambanks

Table A.2

BIRDS POTENTIALLY FOUND IN THE BLACK HILLS

Common Name	Scientific Name	Season Present	Status (1)	Habitat
Common Loon	<u>Gavia immer</u>	Fall	Casual Transient	Lakes
Red-Necked Grebe	<u>Podiceps grisegena</u>	Fall	Casual	Lakes and Streams
Horned Grebe	<u>Podiceps auritus</u>	Winter	Casual	Lakes
Eared Grebe	<u>Podiceps caspicus</u>	Spring and Fall	Uncommon Transient	Lakes
Western Grebe	<u>Aechmophorus occidentalis</u>	Spring and Fall	Casual Transient	Lakes
Pied-Billed Grebe	<u>Podilymbus podiceps</u>	Spring and Fall	Uncommon Transient	Lakes, Ponds, and Streams
Double-Crested Cormorant	<u>Phalacrocorax auritus</u>	Summer	Casual Transient	Lakes
Great Blue Heron	<u>Ardea herodias</u>	Summer	Rare Resident	Large Streams
Least Bittern	<u>Icthyophaga exilis</u>	Spring	Casual Transient	Marshy Areas
Canada Goose	<u>Branta canadensis</u>	Spring and Fall	Fairly Common Transient	Lakes and Ponds
Snow Goose	<u>Chen hyperborea</u>	Winter	Casual Transient	Lakes
Mallard	<u>Anas platyrhynchos</u>	Spring and Fall	Abundant Transient	Lakes, Beaver Ponds with Marshy Borders
Gadwall	<u>Anas strepera</u>	Winter Resident, Spring and Fall Transient	Common	Lakes and Streams
Pintail	<u>Anas acuta</u>	Spring and Fall	Uncommon Transient	Lakes, Ponds, and Marshes
Green-Winged Teal	<u>Anas carolinensis</u>	Spring and Fall	Uncommon Transient	Lakes, Ponds and Marshes
Blue-Winged Teal	<u>Anas discors</u>	Spring and Fall	Uncommon Transient	Lakes and Beaver Ponds
American Widgeon	<u>Mareca americana</u>	Spring and Fall	Fairly Common Transient	Lakes, Streams, and Marshes
Shoveler	<u>Spatula clypeata</u>	Spring and Fall	Common Transient	Lakes, Ponds, and Marshes
Wood Duck	<u>Aix sponsa</u>	Spring and Fall	Irregular	Lakes
Redhead	<u>Aythya americana</u>	Spring and Fall	Uncommon Transient	Lakes
Ring-Necked Duck	<u>Aythya collaris</u>	Winter	Occasional	Lakes

(1) Terms denoting relative abundance have the following meanings:

Abundant. In breeding season and winter: 20 or more individuals can be seen per hour during a trip in suitable habitat. During migration:

100 or more in suitable habitat.

Very common. Breeding season and winter: 10 to 20 per hour. Migration: 50 to 100 per hour.

Common. Breeding season and winter: 5 to 10 per hour. Migration: 25 to 50 per hour.

Fairly common. Breeding season and winter: 2 to 5 per hour. Migration: 10 to 25 per hour.

Uncommon. Breeding season and winter: one per hour. Migration: 2 to 10 per hour.

Rare. Breeding season and winter: one per hour in favorable habitat and not regularly. Migration: one or none per hour at height of normal period.

Casual, irregular, or occasional: one or none in period of several years.

Table A.2 (continued)

Common Name	Scientific Name	Season Present	Status (1)	Habitat
Canvasback	<u>Aythya valisineria</u>	Spring and Fall	Uncommon Transient	Large Lakes
Lesser Scaup	<u>Aythya affinis</u>	Spring and Fall	Common Transient	Large Lakes
Common Goldeneye	<u>Bucephala clangula</u>	Winter	Common Resident	Open Water
Ruddy Duck	<u>Oxyura jamaicensis</u>	Fall	Uncommon Transient	Lakes
Hooded Merganser	<u>Lophodytes cucullatus</u>	Winter	Rare Resident	Lakes and Ponds
Common Merganser	<u>Mergus merganser</u>	Winter	Common Resident	Lakes
Turkey Vulture	<u>Cathartes aura</u>	Summer	Common to Uncommon Resident	Mainly Open Country
Goshawk	<u>Accipiter gentilis</u>	Winter and Summer	Uncommon to Winter, Rare Summer Resident	Pine Forest
Sharp-Shinned Hawk	<u>Accipiter striatus</u>	Year-round	Fairly Common Resident	Pine Forest and Deciduous Woodlands
Cooper's Hawk	<u>Accipiter cooperii</u>	Permanent	Uncommon to Rare Resident	Pine Forest and Deciduous Woodlands
Red-Tailed Hawk	<u>Buteo jamaicensis</u>	Summer	Common Resident	Steep Rocky Hillsides
Broad-Winged Hawk	<u>Buteo platypterus</u>	Summer	Occasional	
Swainson's Hawk	<u>Buteo swainsoni</u>	Winter	Rare Visitor	Prairies
Rough-Legged Hawk	<u>Buteo lagopus</u>	Winter	Uncommon Resident	Prairies
Ferruginous Hawk	<u>Buteo regalis</u>	Winter	Casual	Prairies
Golden Eagle	<u>Aquila chrysaetos</u>	Permanent	Uncommon to Rare Resident	Wide-ranging Throughout the Black Hills
Bald Eagle	<u>Haliaeetus leucocephalus</u>	Winter	Uncommon Resident	Mountain Valleys and Prairies
Marsh Hawk	<u>Circus cyaneus</u>	Spring and Fall	Uncommon Transient	Open Country
Osprey	<u>Pandion haliaetus</u>	Spring	Uncommon Transient	Larger Streams and Lakes
Prairie Falcon	<u>Falco mexicanus</u>	Permanent	Uncommon Resident	Deep Canyons
Peregrine Falcon	<u>Falco peregrinus</u>	Summer	Rare Resident	Deep Canyons
Pigeon Hawk	<u>Falco columbarius</u>	Permanent	Rare Resident	Open Pine Forests
Sparrow Hawk	<u>Falco sparverius</u>	Summer	Common Resident	Open Valleys and Meadows
Ruffed Grouse	<u>Bonasa umbellus</u>	Permanent	Uncommon Resident	Aspen Groves
Sharp-Tailed Grouse	<u>Pedioecetes phasianellus</u>	Permanent	Fairly Common Resident	Prairies
Redwhite	<u>Collinus virginianus</u>	Winter	Irregular	Prairies
California Quail	<u>Lophortyx californicus</u>	Introduced	Uncertain	Farmland
Ring-Necked Pheasant	<u>Phasianus colchicus</u>	Permanent	Uncommon Resident	Weedy Fields and Pastures
Turkey	<u>Meleagris gallopavo</u>	Permanent	Resident	Pine Forests Near Water
Sandhill Crane	<u>Grus canadensis</u>	Fall	Very Common	Prairies

Table A.2 (continued)

Common Name	Scientific Name	Season Present	Status (1)	Habitat
Virginia Rail	<u>Ballus limicola</u>	Winter	Irregular	Grassy-Shrubby Canyons
Sora	<u>Porzana carolina</u>	Summer	Rare Irregular	Marshy Areas
American Coot	<u>Fulica americana</u>	Spring and Fall	Transient	Lakes and Marshes
Semipalmated Plover	<u>Charadrius semipalmatus</u>	Spring	Irregular	Lakes
Killdeer	<u>Charadrius vociferus</u>	Summer	Common Resident	Lakes and Ponds
Common Snipe	<u>Capella gallinago</u>	Winter	Uncertain	Muddy Stream Banks
Long-Billed Curlew	<u>Numenius americanus</u>	Summer	Rare Transient	Shores and Lakes
Upland Plover	<u>Bartamus longicauda</u>	Summer	Rare Resident	Shores and Lakes
Spotted Sandpiper	<u>Actitis macularia</u>	Summer	Common Resident	Edges of Stream and Beaver Ponds
Solitary Sandpiper	<u>Tringa solitaria</u>	Spring and Fall	Uncommon Transient	Lakes and Ponds
Willet	<u>Catoptrophorus semipalmatus</u>	Spring and Fall	Rare Transient	Lakes and Ponds
Western Sandpiper	<u>Recurvirostra americana</u>	Summer	Irregular	Marshes
American Avocet	<u>Steganopus tricolor</u>	Spring and Fall	Rare Transient	Lakes
Wilson's Phalarope	<u>Larus delawarensis</u>	Winter and Spring	Irregular	
Ring-Billed Gull	<u>Larus pipixcan</u>	Spring and Fall	Rare Transient	
Franklin's Gull	<u>Columba fasciata</u>	Summer	Rare Visitant	
Band-Tailed Pigeon	<u>Zenaidura macroura</u>	Summer	Common to Abundant Resident	Pine Forests
Mourning Dove	<u>Coccyzus americanus</u>	Summer	Rare Resident	
Yellow-Billed Cuckoo	<u>Coccyzus erythrophthalmus</u>	Summer	Uncommon Resident	Cottonwood Groves
Black-Billed Cuckoo	<u>Tyto alba</u>	Uncertain	Uncertain	
Barn Owl	<u>Otus asio</u>	Permanent	Rare Resident	
Screech Owl	<u>Bubo virginianus</u>	Permanent	Common Resident	Coniferous and Deciduous Forests
Great Horned Owl	<u>Speotyto cunicularia</u>	Summer		Prairies
Burrowing Owl	<u>Strix varia</u>	Summer	Uncertain	
Barred Owl	<u>Asio otus</u>	Summer	Rare	Dense Pine Forests
Long-Eared Owl	<u>Negolius acadicus</u>	Permanent	Uncertain	
Saw-Whet Owl	<u>Caprimulgus vociferus</u>		Uncertain	
Whip-Poor-Will	<u>Phalaenoptilus nuttallii</u>	Summer	Uncommon to Rare	Dry, Rocky Slopes with Scattered Pines
Poor-Will	<u>Chordeiles minor</u>	Summer	Common Resident	Open Forests
Common Nighthawk	<u>Chaetura pelagica</u>	Summer	Uncommon Resident	Chimneys
Chimney Swift				

Table A.2 (continued)

Common Name	Scientific Name	Season Present	Status (1)	Habitat
White-Throated Swift	<u>Aeronautes saxatilis</u>	Summer	Common Resident	Cliffs
Calliope Hummingbird	<u>Stellula calliope</u>	Summer	Uncertain	
Belted Kingfisher	<u>Megascops alcyon</u>	Permanent	Common Resident	Streams and Lakes
Yellow-Shafted Flicker	<u>Colaptes auratus</u>	Summer	Common Resident	Pine Forests
Red-Shafted Flicker	<u>Colaptes cafer</u>	Summer	Common Resident	Pine Forests
Red-Headed Woodpecker	<u>Melanerpes erythrocephalus</u>	Summer	Uncertain Resident	Agricultural Lands
Lewis' Woodpecker	<u>Amyndemus lewis</u>	Summer	Uncertain Resident	Pine Forests
Yellow-Bellied Sapsucker	<u>Sphyrapicus varius</u>	Summer	Uncertain Resident	Pine and Aspen Woods
Hairy Woodpecker	<u>Dendrocopos villosus</u>	Permanent	Common Resident	Pine and Aspen Woods
Downy Woodpecker	<u>Dendrocopos pubescens</u>	Permanent	Fairly Common Resident	Deciduous Woods
Black-Backed Three-Toed Woodpecker	<u>Picoides arcticus</u>	Permanent	Uncertain Resident	Coniferous Forests
Northern Three-Toed Woodpecker	<u>Picoides tridactylus</u>	Permanent	Rare Resident	Spruce Forests
Eastern Kingbird	<u>Tyrannus tyrannus</u>	Summer	Common Resident	Prairies
Western Kingbird	<u>Tyrannus verticalis</u>	Summer	Uncertain Resident	Open Country
Eastern Phoebe	<u>Sayornis phoebe</u>	Summer	Rare Resident	Prairies
Say's Phoebe	<u>Sayornis saya</u>	Summer	Uncertain Resident	Prairies
Least Flycatcher	<u>Empidonax minimus</u>	Uncertain	Uncertain	
Dusky Flycatcher	<u>Empidonax oberholseri</u>	Summer	Common Resident	Aspen Groves
Western Flycatcher	<u>Empidonax difficilis</u>	Summer Resident	Common to Very Common	Canyons, Near Water
Western Wood Pewee	<u>Contopus sordidulus</u>	Summer Resident	Common to Abundant	Pine Forests
Olive-Sided Flycatcher	<u>Mniotiltus borealis</u>	Summer	Casual Transient	Pine Forests
Horned Lark	<u>Fringilla alpestris</u>	Summer	Common Resident	Dry, Open Country
Violet-Green Swallow	<u>Tachycineta thalassina</u>	Summer	Common Resident	Steep Canyons, Beaver Ponds
Tree Swallow	<u>Iridoprocne bicolor</u>	Uncertain	Rare Transient	
Bank Swallow	<u>Hirundo lunifrons</u>	Uncertain	Rare Transient	
Rough-Winged Swallow	<u>Stelgidopteryx serripennis</u>	Summer	Common Resident	Beaver Ponds and Lakes
Barn Swallow	<u>Hirundo lunifrons</u>	Summer	Uncertain Resident	Farmyards and Beaver Ponds
Cliff Swallow	<u>Petrochelidon pyrrhonota</u>	Summer	Uncertain Resident	Steep Cliffs and Beaver Ponds
Gray Jay	<u>Perisoreus canadensis</u>	Permanent	Fairly Common Resident	Dense Pine and Spruce
Blue Jay	<u>Cyanocitta cristata</u>	Permanent	Common Resident	Oak Woods
Stellar's Jay	<u>Cyanocitta stelleri</u>	Uncertain	Uncertain	
Common Raven	<u>Corvus corax</u>	Uncertain	Uncertain	
Common Crow	<u>Corvus brachyrhynchos</u>	Spring and Fall	Common Transient	Pine Forests

Table A.2 (continued)

Common Name	Scientific Name	Season Present	Status (1)	Habitat
Pilem Jay	<u>Oreothlypis cyanocephala</u>	Permanent	Common Resident	Pine Forests
Clark's Nutcracker	<u>Neotigra columbiana</u>	Spring and Fall	Rare Visitor	
Black-Capped Chickadee	<u>Parus strickgillii</u>	Permanent	Abundant Resident	Pine, Spruce and Aspen Woods
White-Breasted Nuthatch	<u>Sitta carolinensis</u>	Permanent	Fairly Common	Pine
Red-Breasted Nuthatch	<u>Sitta canadensis</u>	Permanent	Common Resident	Pine and Spruce Forests
Pygmy Nuthatch	<u>Sitta pygmaea</u>	Uncertain	Uncertain	Pine Forests
Brown Creeper	<u>Certhia familiaris</u>	Permanent	Uncertain Resident	Pine and Spruce Forests
Dipper	<u>Cinclus mexicanus</u>	Permanent	Uncertain Resident	Mountain Streams
House Wren	<u>Troglodytes aedon</u>	Summer	Common Resident	Deciduous Thickets
Winter Wren	<u>Troglodytes troglodytes</u>	Spring and Fall	Uncertain	Brush Piles
Long-Billed Marsh Wren	<u>Telmatoctes palustris</u>	Winter	Uncertain	
Carson Wren	<u>Catherpes mexicanus</u>	Summer	Uncertain Resident	Vertical Cliffs
Rock Wren	<u>Sialia sialis</u>	Summer	Common to Uncertain	Rocky Outcrops
Mockingbird	<u>Mimus polyglottos</u>	Spring	Uncertain	Occasional
Catbird	<u>Dumetella carolinensis</u>	Summer	Fairly Common	In the Vicinity of People
Brown Thrasher	<u>Toxostoma rufum</u>	Summer	Fairly Common	Thickets
Robin	<u>Turdus migratorius</u>	Summer	Abundant Resident	Pine and Spruce Forests
Varied Thrush	<u>Icterus naevius</u>	Winter	Uncertain	
Hermit Thrush	<u>Hylocichla guttata</u>	Summer	Uncertain	
Swainson's Thrush	<u>Hylocichla ustulata</u>	Summer	Fairly Common	Spruce Forests
Gray-Cheeked Thrush	<u>Hylocichla minima</u>	Spring	Rare Transient	
Veery	<u>Hylocichla fuscescens</u>	Summer	Common Resident	Dense Woods
Eastern Bluebird	<u>Sialia sialis</u>	Summer	Uncertain to Rare	Edges of Pine Forests
Mountain Bluebird	<u>Sialia currucoides</u>	Summer	Very Common	Pine Forest Edges
Townsend's Solitaire	<u>Myadestes townsendi</u>	Permanent	Common	Pine and Spruce Forests
Golden-Crowned Kinglet	<u>Regulus satrapa</u>	Permanent	Uncertain Resident	Spruce Forests
Ruby-Crowned Kinglet	<u>Regulus calendula</u>	Summer	Rare Resident	Spruce Forests
Water Pipit	<u>Anthus spinoletta</u>	Fall	Uncertain	Dry Streams
Cedar Waxwing	<u>Bombycilla cedrorum</u>	Permanent	Rare to Uncertain	Residential Areas
Bohemian Waxwing	<u>Bombycilla garrulus</u>	Winter and Early Spring	Fairly Common	Mountain-Ash
Northern Shrike	<u>Lanius excubitor</u>	Winter	Rare Visitor	Pine
Loggerhead Shrike	<u>Lanius ludovicianus</u>	Summer	Rare to Uncertain	Open Country

Table A.2 (continued)

Common Name	Scientific Name	Season Present	Status (1)	Habitat
S. virens	<u>Sturnus vulgaris</u>	Permanent	Fairly Common	Cottonwoods
Bell's Vireo	<u>Vireo bellii</u>	Uncertain	Uncertain	
Solitary Vireo	<u>Vireo solitarius</u>	Summer	Common	Pine Forests
Red-Eyed Vireo	<u>Vireo olivaceus</u>	Summer	Common	Deciduous Streamside Woods
Warbling Vireo	<u>Vireo gilvus</u>	Summer	Common	Deciduous Streamside Woods
Black-and-white Warbler	<u>Mniotilta varia</u>	Summer	Uncertain	
Tennessee Warbler	<u>Vermivora peregrina</u>	Spring	Uncertain	
Orange-Crowned Warbler	<u>Vermivora celata</u>	Spring and Fall	Rare to Transient	Streamside Woods
Nashville Warbler	<u>Vermivora ruficapilla</u>	Summer	Uncertain	
Yellow Warbler	<u>Dendroica petechia</u>	Summer	Very Common	Streamside Woods
Myrtle Warbler	<u>Dendroica coronata</u>	Spring and Fall	Uncommon to Rare	Streamside Woods
Audubon's Warbler	<u>Dendroica auduboni</u>	Summer	Common Resident	Pine and Spruce Forests
Blackpoll Warbler	<u>Dendroica striata</u>	Spring	Uncommon Transient	Streamside Woods
Palm Warbler	<u>Dendroica palmarum</u>	Uncertain	Uncertain	
Ovenbird	<u>Seiurus aurocapillus</u>	Summer	Fairly Common	Deciduous Woods
Northern Waterthrush	<u>Seiurus noveboracensis</u>	Spring and Fall	Probably Rare	Willow Thickets
McGillivray's Warbler	<u>Oporornis tolmiei</u>	Summer	Uncommon	Willow Thickets
Yellowthroat	<u>Geothlypis trichas</u>	Summer	Common Resident	Willow Thickets
Yellow-Breasted Chat	<u>Icteria virens</u>	Summer	Fairly Common	Willow Thickets
Wilson's Warbler	<u>Wilsonia pusilla</u>	Spring and Fall	Uncommon to Rare	
American Redstart	<u>Setophaga ruticilla</u>	Summer	Fairly Common	Deciduous Woods
House Sparrow	<u>Passer domesticus</u>	Permanent	Abundant	Farm and Ranch Land
Bobolink	<u>Dolichonyx oryzivorus</u>	Summer	Rare	Agricultural Land
Western Meadowlark	<u>Sturnella neglecta</u>	Summer	Abundant	Grasslands
Red-Winged Blackbird	<u>Agelaius phoeniceus</u>	Summer	Common	Cattail and Sedge Marshes
Orchard Oriole	<u>Icterus spurius</u>	Summer	Uncommon Resident	Cottonwoods
Baltimore Oriole	<u>Icterus galbula</u>	Spring	Uncommon Transient	
Bellock's Oriole	<u>Icterus bellockii</u>	Summer	Fairly Common	Cottonwoods
Rusty Blackbird	<u>Euphagus carolinus</u>	Uncertain	Rare	
Brewer's Blackbird	<u>Euphagus cyanocephalus</u>	Summer	Fairly Common	Prairies
Common Grackle	<u>Quiscalus quiscula</u>	Summer	Common Resident	Cottonwoods and Pines
Brown-Headed Cowbird	<u>Molothrus ater</u>	Spring and Fall	Uncommon Transient	Streamside Thickets
Western Tanager	<u>Piranga ludoviciana</u>	Summer	Common	Pine Forests

Table A.2 (continued)

Common Name	Scientific Name	Season Present	Status (1)	Habitat
Cardinal	<u>Richmondia cardinalis</u>	Spring	Uncertain	
Rose-Breasted Grosbeak	<u>Phenictus ludovicianus</u>	Summer	Rare	
Black-Headed Grosbeak	<u>Phenictus melanoccephalus</u>	Summer	Uncertain	Deciduous Thickets
Blue Grosbeak	<u>Quiraca caerulea</u>	Summer	Rare Resident	
Indigo Bunting	<u>Passerina cyanea</u>	Summer	Rare Resident	Deciduous Thickets
Lazuli Bunting	<u>Passerina amoena</u>	Summer	Common Resident	Deciduous Thickets
Dickcissel	<u>Spiza americana</u>	Summer	Irregular Resident	Tall Grass Prairies
Evening Grosbeak	<u>Hesperiphona vespertina</u>	Spring and Fall	Common Transient	Cottonwoods
Cassin's Finch	<u>Carpodacus cassinii</u>	Winter	Uncertain	
Pine Grosbeak	<u>Pinicola enucleator</u>	Summer	Casual	Spruce
Gray-Crowned Rosy Finch	<u>Leucosticte tephrocotis</u>	Winter	Sporadic	
Common Redpoll	<u>Acanthis flammea</u>	Winter	Uncertain	Pine Forests
Pine Siskin	<u>Spinus pinus</u>	Permanent	Abundant	Pine
American Goldfinch	<u>Spinus tristis</u>	Summer	Common Resident	Cottonwoods and Willows
Red Crossbill	<u>Lousia curvirostra</u>	Anytime of Year	Sporadic Visitor	Coniferous Forests
White-Winged Crossbill	<u>Lousia leucoptera</u>	Uncertain	Uncertain	Spruce
Rufous-Sided Towhee	<u>Pipilo erythrophthalmus</u>	Summer	Common Resident	Aspen Thickets
Lark Bunting	<u>Calamospiza melanocorys</u>	Summer	Uncertain Resident	Dry Grasslands
Savannah Sparrow	<u>Passerculus sandwichensis</u>	Spring and Fall	Uncertain to Rare	
Grasshopper Sparrow	<u>Ammodramus savannarum</u>	Summer	Sporadic Resident	Dry Grasslands
Baird's Sparrow	<u>Ammodramus bairdii</u>	Summer	Common	Grasslands
Vesper Sparrow	<u>Poocetes gramineus</u>	Summer	Fairly Common	Dry Grasslands
Lark Sparrow	<u>Chondestes grammacus</u>	Summer	Common	Open Dry Country
White-Winged Junco	<u>Junco aikeni</u>	Permanent	Very Common	Pine or Spruce Forests
Slate-Colored Junco	<u>Junco hyemalis</u>	Winter	Fairly Common	Deciduous Woods
Oregon Junco	<u>Junco oregonus</u>	Winter	Common Resident	Deciduous Woods
Gray-Headed Junco	<u>Junco caniceps</u>	Uncertain	Uncertain	
Tree Sparrow	<u>Spizella arborea</u>	Winter	Common Resident	Streamside Thickets
Chipping Sparrow	<u>Spizella passerina</u>	Summer	Abundant Resident	Open Forests of Pine and Spruce
Clay-Colored Sparrow	<u>Spizella pallida</u>	Spring and Fall	Common	Pastures
Field Sparrow	<u>Spizella pusilla</u>	Spring and Fall	Rare Transient	Pastures
Harrie's Sparrow	<u>Zonotrichia querula</u>	Spring and Fall	Rare Transient	

Table A.2 (continued)

Common Name	Scientific Name	Season Present	Status (1)	Habitat
White-Crowned Sparrow	<u>Zonotrichia leucophrys</u>	Spring and Fall	Common Transient	Streamside Thickets
White-Throated Sparrow	<u>Zonotrichia albicollis</u>	Spring and Fall	Rare or Irregular	
Fox Sparrow	<u>Passerella iliaca</u>	Uncertain	Rare Transient	Streamside Thickets
Lincoln's Sparrow	<u>Melospiza lincolni</u>	Spring and Fall	Uncommon Transient	Streamside Thickets
Song Sparrow	<u>Melospiza melodia</u>	Permanent	Fairly Common	Streamside Thickets

Table A.3

MAMMALS POTENTIALLY FOUND IN THE BLACK HILLS

<u>Common Name</u>	<u>Scientific Name</u>
Masked Shrew	<u>Sorex cinereus</u>
Vagrant Shrew	<u>Sorex vagrans</u>
Dwarf Shrew	<u>Sorex nanus</u>
Keen Myotis Bat	<u>Myotis keeni</u>
Little Brown Myotis Bat	<u>Myotis lucifugus</u>
Fringed Myotis Bat	<u>Myotis thysanodes</u>
Long-Eared Myotis Bat	<u>Myotis evotis</u>
Western Brown Bat	<u>Myotis volans</u>
Small-Footed Myotis Bat	<u>Myotis subulatus</u>
Silver-Haired Bat	<u>Lasionycteris noctivagans</u>
Red Bat	<u>Lasiurus borealis</u>
Big Brown Bat	<u>Eptesicus fuscus</u>
Hoary Bat	<u>Lasiurus cinereus</u>
Western Big-Eared Bat	<u>Plecotus townsendi</u>
Raccoon	<u>Procyon lotor</u>
Short-Tail Weasel	<u>Mustela erminea</u>
Long-Tail Weasel	<u>Mustela frenata</u>
Mink	<u>Mustela vison</u>
Black-Footed Ferret	<u>Mustela nigripes</u>
River Otter	<u>Lutra canadensis</u>
Badger	<u>Taxidea taxus</u>
Spotted Skunk	<u>Spilogale putorius</u>
Striped Skunk	<u>Mephitis mephitis</u>
Coyote	<u>Canis latrans</u>
Swift Fox	<u>Vulpes velox</u>
Bobcat	<u>Lynx rufus</u>
Yellow-Belly Marmot	<u>Marmota flaviventris</u>
Thirteen-Lined Ground Squirrel	<u>Citellus tridecemlineatus</u>
Least Chipmunk	<u>Eutamias minimus</u>

Table A.3 (continued)

<u>Common Name</u>	<u>Scientific Name</u>
Red Squirrel	<u>Tamiasciurus hudsonicus</u>
Northern Flying Squirrel	<u>Glaucomys sabrinus</u>
Northern Pocket Gopher	<u>Thomomys talpoides</u>
Wyoming Pocket Mouse	<u>Perognathus fasciatus</u>
Hispid Pocket Mouse	<u>Perognathus hispidus</u>
Ord Kangaroo Rat	<u>Dipodomys ordi</u>
Beaver	<u>Castor canadensis</u>
Plains Harvest Mouse	<u>Reithodontomys montanus</u>
Western Harvest Mouse	<u>Reithodontomys megalotis</u>
White-Footed Mouse	<u>Peromyscus leucopus</u>
Deer Mouse	<u>Peromyscus maniculatus</u>
Northern Grasshopper Mouse	<u>Onychomys leucogaster</u>
Eastern Woodrat	<u>Neotoma floridana</u>
Bushy-Tail Woodrat	<u>Neotoma cinerea</u>
Boreal Red-Back Vole	<u>Clethrionomys gapperi</u>
Meadow Vole	<u>Microtus pennsylvanicus</u>
Prairie Vole	<u>Microtus ochrogaster</u>
Long-Tail Vole	<u>Microtus longicaudus</u>
Muskrat	<u>Ondatra zibethicus</u>
Meadow Jumping Mouse	<u>Zapus hudsonius</u>
Porcupine	<u>Erethizon dorsatum</u>
Snowshoe Hare	<u>Lepus americanus</u>
White-Tailed Jackrabbit	<u>Lepus townsendi</u>
Mountain Cottontail	<u>Sylvilagus nuttalli</u>
Whitetail Deer	<u>Odocoileus virginianus</u>

Table A.4

REPTILES AND AMPHIBIANS
POTENTIALLY FOUND IN THE BLACK HILLS

<u>Common Name</u>	<u>Scientific Name</u>
Blotched Tiger Salamander	<u>Ambystoma tigrinum melanostictum</u>
Plains Spadefoot Toad	<u>Scaphiopus bombifrons</u>
Rocky Mountain Toad	<u>Bufo woodhousei woodhousei</u>
Great Plains Toad	<u>Bufo cognatus</u>
Boreal Chorus Frog	<u>Pseudacris triseriata maculata</u>
Leopard Frog	<u>Rana pipiens</u>
Snapping Turtle	<u>Chelydra serpentina</u>
Ornate Box Turtle	<u>Terrapene ornata ornata</u>
Painted Turtle	<u>Chrysemys picta</u>
Western Spiny Softshell Turtle	<u>Trionyx spiniferus hartwegi</u>
Eastern Short-Horned Lizard	<u>Phrynosoma douglassi ornatum</u>
Northern Many-Lined Skink	<u>Eumeces multivirgatus multivirgatus</u>
Six-Lined Racerunner	<u>Cnemidophorus sexlineatus</u>
Plains Hognose Snake	<u>Heterodon nasicus nasicus</u>
Eastern Yellow-Bellied Racer	<u>Coluber constrictor flaviventris</u>
Smooth Green Snake	<u>Opheodrys vernalis</u>
Bullsnake	<u>Pituophis melanoleucus sayi</u>
Pale Milk Snake	<u>Lampropeltis triangulum</u>
Red-Bellied Snake	<u>Storeria occipitomaculata pahasapae</u>
Red-Sided Garter Snake	<u>Thamnophis sirtalis parietalis</u>
Plains Garter Snake	<u>Thamnophis radix</u>
Wandering Garter Snake	<u>Thamnophis elegans vagrans</u>
Prairie Rattlesnake	<u>Crotalus viridis viridis</u>

Source: R. C. Stebbins. 1966. *A Field Guide to Western Reptiles and Amphibians*.
Boston: Houghton Mifflin Co.

TECHNICAL REPORT

FACILITIES PLAN

LEAD-DEADWOOD SANITARY DISTRICT NO.1
DEADWOOD, SOUTH DAKOTA



FACILITIES PLAN
TECHNICAL REPORT
for
LEAD-DEADWOOD SANITARY DISTRICT NO. 1
DEADWOOD, SOUTH DAKOTA



Prepared by
CH2M HILL, INC.
12000 East 47th Avenue
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May 1976

Project No. D9054.0

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ACKNOWLEDGMENTS

During the facilities planning procedure, several review meetings were held with various local, State and Federal agencies and public interest groups. The major objectives of these review sessions were to agree upon selective alternative wastewater management systems to be evaluated and to keep the various groups fully informed about the progress of the Facilities Plan. The following agencies and local groups attended the various review meetings and provided invaluable input to the direction of the facilities planning procedure:

- Lead-Deadwood Sanitary District No. 1 (District)
- Homestake Mining Company (HMC)
- Environmental Protection Agency, Region VIII (EPA)
- South Dakota Department of Environmental Protection (DEP)
- U.S. Forest Service
- Bureau of Land Management (BLM)
- Soil Conservation Service (SCS)
- Farmers Home Administration (FmHA)
- United Steel Workers of America, Local 7044
- Sixth District Council of Local Governments
- State Planning Bureau
- Save Centennial Valley Association

FACILITIES PLAN REPORT ORGANIZATION

This Facilities Plan study report consists of four documents:

- Administrative Report. The Administrative Report is a summary of the significant findings of the Facilities Plan and Environmental Assessment. It is a concise presentation of the selected wastewater management system, major background information, the most feasible wastewater management alternatives, and the basic issues surrounding those alternatives.
- Technical Report. The Technical Report contains supportive technical information for the Administrative Report and Environmental Assessment and documents the steps and decisions that evolved during the Facilities Plan study.
- Environmental Assessment. The assessment is an analysis of the environmental aspects of the proposed project, augmented by a discussion of the alternatives considered. This report is intended to supplement the Facilities Plan and to assist the U.S. Environmental Protection Agency's analysis of the ramifications of the project as required by the National Environmental Policy Act.
- Appendices. The Appendices contain detailed background material and copies of the various task reports developed during the facilities planning procedure. They document the basic data supporting the issues and conclusions discussed in the Administrative and Technical Reports. Copies of the Appendices are available for inspection at the Lead-Deadwood Sanitary District No. 1.

The complete Facilities Plan includes the revision of the draft Facilities Plan study report, documentation of public hearings, and a detailed description of the selected wastewater management alternative.

Throughout this report a distinction is made between the water quality objective, water quality standards or criteria, and effluent limitations. The water quality objective is the State's beneficial use designation of a cold water fishery for Whitewood Creek. The water quality criteria are the parameters determined by the State to achieve the water quality objective. The effluent limitations (based on the water quality criteria) are the discharge parameters specified in the National Pollution Discharge Elimination System (NPDES) Discharge Permits.

PREFACE

In July 1975, a draft of the Lead-Deadwood Sanitary District No. 1 Facilities Plan was completed. The report concluded that the most economical system for meeting the required effluent limitations was an advanced wastewater treatment (AWT) biological plant located in lower Deadwood near the rodeo grounds. At the time, the effluent limitations as set in the District's NPDES Discharge Permit were based on the State's water quality objective of achieving a permanent cold water fishery in Whitewood Creek. The draft also noted several concerns about the ability of the District to implement the AWT plant or any system that would achieve the State's objective. These concerns are discussed in Chapter 8 of this Technical Report.

On the basis of the information in the draft Facilities Plan, the District sought to get the effluent limitations lowered. Two legal actions resulted. First, the State of South Dakota changed the stream classification of Whitewood Creek below Deadwood from a permanent to a marginal cold water fishery. Second, on 5 March 1976, the State Department of Environmental Protection (DEP) issued an order that waived the water quality objective to allow secondary treatment of the District's wastes with the provision for upgrading the treatment system by 1 July 1988 to meet the marginal cold water fishery objective if future evidence shows that Whitewood Creek will rehabilitate itself by that date. This 5 March 1976 order is presented at the end of this Preface.

All the information in the Facilities Plan appendix reports and this Technical Report, except for Chapter 8, was developed before these two legal actions occurred. Those report sections therefore document the facilities planning work that was completed while the permanent cold water fisheries objective was still in effect. Chapter 8 of this report, the Administrative Report and the Environmental Assessment have been written to reflect the legal changes in the effluent limitations and to document the subsequent facilities planning work and decisions.

Before the Secretary
Department of Environmental Protection
State of South Dakota

*
In the matter of Lead-Deadwood *
Sanitary District No. 1, *
P.O. Box 51, Deadwood, *
South Dakota 57732 *
Norman Bakke, as President * ORDER
James Dunn, as Vice-President *
and Renaldo Gallo, as Secretary *
of the District's Board of *
Trustees *

This matter having come on for hearing before me, David V. Vrooman, Hearing Officer, at Deadwood, South Dakota, on March 1, 2, 3, and 4, 1976, the District having been represented by Jon Mattson, and the Department of Environmental Protection by Lawrence W. Kyte and Warren R. Neufeld, and after review of the pleadings, exhibits, stipulations, and testimony,

IT IS HEREBY ORDERED,

1. That the District and Board construct and have in operation a sewage treatment plant for all domestic wastes generated within the District which will be discharged into Whitewood Creek or its tributaries that will give all wastes secondary treatment by July 1, 1978.

2. That the District construct, at the same time that the construction outlined in Part 1 of this opinion to be completed also by July 1, 1978, additional facilities which will prevent the effluent from causing ammonia nitrogen to exceed 3.0 mg/l at any time in Whitewood Creek and total chlorine residual to exceed 0.02 mg/l. Although this Order requires that the construction of this portion must be completed by July 1, 1978, this portion of the treatment facility need not be put into operation by the District before the latter of the following two dates (a) July 1, 1979, or (b) when in the opinion of the Secretary of the Department of Environmental Protection the operation of this portion of the system will aid the rehabilitation process of the beneficial uses assigned to Whitewood Creek.

3. In order to assure and monitor steps for compliance with the July 1, 1978, date the following interim steps are required:

- (a) The District and Board shall make the selection of an approvable wastewater management system by April 1, 1976.

- (b) The District and Board shall complete and submit a final facilities plan and environmental assessment on the selected wastewater management system to EPA and SDDEP by May 15, 1976.
- (c) The District and Board shall commence construction by April 1, 1977.

4. That the District, and the Board be required to have constructed and operating by July 1, 1988, a sewage treatment plant for all domestic wastes generated within the District, which will be discharged into Whitewood Creek, or its tributaries which will insure that such treated effluent does not violate South Dakota Water Quality Standards applicable to Whitewood Creek;

5. That any sewage treatment plant to be constructed by the district shall not discharge effluents into any portion of the water of Whitewood Creek or its tributaries which have not previously been affected by the municipal or industrial discharges from within the district if such discharges will cause a violation of Water Quality Standards or significant degradation in such segments or water;

6. That the District and the Board be allowed an opportunity to petition the secretary prior to July 1, 1985, for a re-hearing and present new evidence which would show that avoidance of compliance with State Water Quality Standards by the District would be justified beyond July 1, 1988, as required by part four of this order. Such evidence would have to show that the affected area of Whitewood Creek will not have rehabilitated itself by July 1, 1988, or soon thereafter, to the extent that it will be suitable as cold water marginal fish life propagation waters. This evidence could include but not necessarily be limited to, stream or biological data. Further, that this order shall be subject to modification and extension of the July 1, 1988, deadline for compliance by the Secretary or the Board of Environmental Protection. Such modification or extension of time for requiring additional treatment shall be based upon a reasonable estimate shown as to when rehabilitation from previous waste discharges will have been sufficient to allow establishment of a cold water fishery, or time needed for additional study to determine a reasonable estimate of the time needed for recovery.

7. The District and the Board shall submit to the South Dakota Department of Environmental Protection a report on the results of effluent or water quality samples to be taken by the District or its agents at least semiannually; and

8. The secretary may modify the time schedules set out in this order upon a timely petition and a showing by the District and the Board that there is good cause for revision because of delays in construction due to work stoppage, delays in receiving equipment or materials ordered by the

contractor, unusual weather conditions or other construction and implementation problems beyond the control of the District and its Board and that the District has acted diligently and in good faith to comply with this order.

Signed and dated this 5th day of March, 1976.

(signed)

DAVID V. VROOMAN
Hearing Officer

Suite 517 101 S. Main
Sioux Falls, South Dakota 57102

CERTIFICATE OF SERVICE

I, David V. Vrooman, do hereby certify that a true and correct copy of the above and foregoing Order in the above entitled matter was served upon Jon Mattson, attorney for Lead-Deadwood Sanitary District No. 1, 696 Main Street, Deadwood, South Dakota 57732, and Lawrence W. Kyte, attorney for the Department of Environmental Protection, Room 415, Foss Office Bldg., Pierre, South Dakota 57501; and that said copies were duly served by first class mail, postage prepaid, this 5th day of March, 1976.

(signed)

DAVID V. VROOMAN

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Chapter 1 INTRODUCTION

A Facilities Plan study of alternative wastewater management systems for the Lead-Deadwood Sanitary District No. 1 (District) has been completed. Drafts of this Technical Report documenting the study have been reviewed by the public and various government agencies. The significant review comments and suggestions have been included in this final document.

STUDY OBJECTIVES AND SCOPE

The study objectives of the Facilities Plan were to define wastewater management design criteria, to develop alternative management systems, and to select an optimum treatment process that would minimize economic investment and maximize beneficial social and environmental impacts.

As defined by the Federal Water Pollution Control Act Amendments of 1972, a facilities plan is a document comprising text and maps that present a systematic economic and environmental evaluation of feasible alternatives for wastewater treatment and disposal for a given geographical area. Such a plan must meet the following criteria:

- It must provide for meeting the required effluent limitations.
- It must be cost effective, in that the plan must involve the least cost to society.
- It must provide the flexibility to accommodate necessary changes that may develop.
- It must be environmentally sound.
- It must satisfy the personal and community concerns of the people affected.

The facilities planning procedure assures the public and all levels of government that decisions regarding facilities are soundly made and take into consideration all relevant factors.

To meet the study objectives, the Facilities Plan study scope included (1) investigation of existing conditions, (2) review of State and Federal water quality regulations, (3) review of treatment methods needed to achieve the required effluent limitations, (4) development of alternative wastewater management systems, (5) preliminary screening of the alternatives, and (6) detailed comparative examination of the remaining alternatives.

The Facilities Plan study scope also calls for a two-part evaluation of the cost to reduce extraneous flows entering the collection system. The first part is an Infiltration and Inflow Analysis to determine if excess flow is present in the collection system and to evaluate the cost of controlling this problem. The second part is an Infiltration and Inflow Survey, to be initiated only on (1) approval by the Regional Administrator of the EPA and (2) demonstration of its necessity in the Infiltration and Inflow Analysis. The survey would involve a detailed inventory of the collection system and TV monitoring. The State and EPA have indicated that the Infiltration and Inflow Survey will not be needed.

As part of the Facilities Plan, the Grizzly Gulch Wastewater Management Proposal was evaluated to answer the significant questions raised by the EPA regarding the proposed project's environmental impact. This evaluation included a review of the soils, hydrology, geology, and floral and faunal communities indigenous to the Grizzly Gulch site. After the evaluation was completed, modifications to the proposed plan were suggested. The Grizzly Gulch Wastewater Management Plan, supplemented by the environmental review, is included as one of the alternatives analyzed in the Facilities Plan study.

The inclusion of Homestake Mining Company (HMC), which is the major industry in the service area, in the Facilities Plan procedure was due to the unique relationship between the District and HMC. To accomplish the study objectives, detailed analyses of combined versus separate treatment systems and HMC's waste system were required. HMC is presently conducting several studies of its own, and this effort was coordinated with the work required for the Facilities Plan. In addition, the EPA requested that HMC be included in the planning procedure.

PLANNING AREA

Figure 1.1 defines the planning area considered by the District in the facilities planning procedure. The planning area has been reviewed and approved by the State Planning Bureau and the Sixth Planning and Development District in Rapid City, South Dakota. The planning area can be generally described as the area lying tributary to Whitewood Creek below Deadwood. The only part of the study area not in the Whitewood basin is a new subdivision near the Terry Peak ski area that lies in the Spearfish Creek drainage basin. This subdivision was included because its utility services can be most logically supplied from Lead-Deadwood.

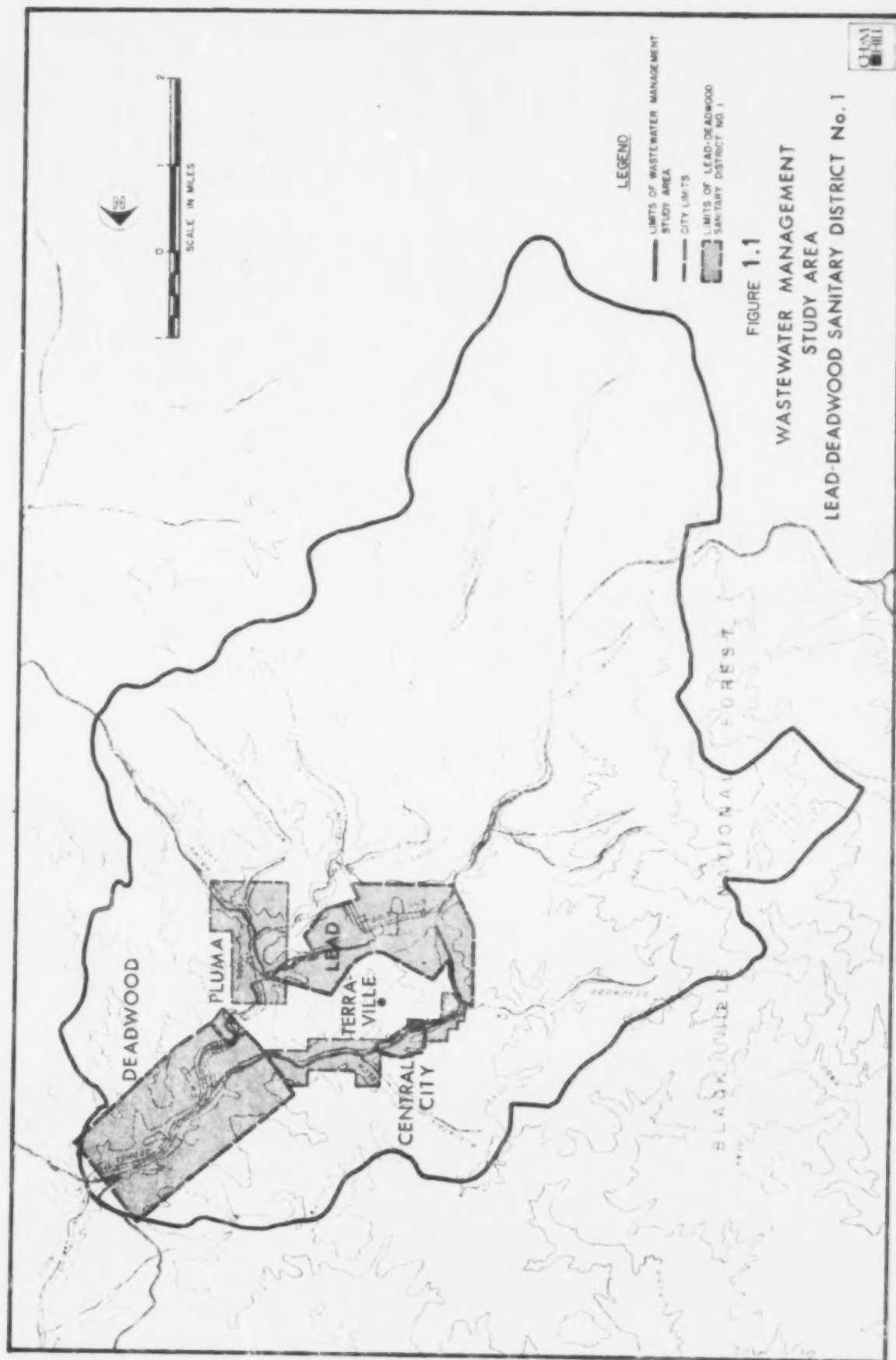
PLANNING PARTICIPATION AND COORDINATION

LOCAL PARTICIPATION

Many local people and agencies participated in the preparation and planning required to produce this study. These participants and their help have been recognized in the Acknowledgments. Chapter 8 reports on the various public hearings and meetings held during the Facilities Plan study.

COORDINATION WITH LOCAL, STATE AND FEDERAL AGENCIES

At the completion of many of the tasks during the study procedure, draft reports were submitted to the various local, regional, State and Federal regulatory agencies listed in the Acknowledgments for their review and comment. These draft reports were provided in an effort to keep these agencies fully informed of the project's progress and to shorten the time required for review and approval of the final report.



Chapter 2

WATER QUALITY OBJECTIVES AND MANAGEMENT GOALS

The effluent limitations established for the Lead-Deadwood area are set forth in the two National Pollution Discharge Elimination System (NPDES) Discharge Permits issued to the District and HMC in January of 1975, shown in Table 2.1. The District's NPDES Discharge Permit has two sets of effluent limitations: one for the District by itself and a second for the District and HMC in a combined collection and treatment system.

The Permits' effluent limitations were adopted as the water quality objective and management goals of this Facilities Plan. The effluent limitations are based on the State of South Dakota discharge requirements, which are more stringent than the Federal regulations. This chapter presents a discussion of the State requirements, the development of the NPDES Discharge Permit limitations, and a review of the Federal requirements.

Throughout the chapter a distinction is made between the State water quality objective, State water quality standards or criteria, and effluent limitations. The water quality objective is the State's beneficial use designation of a cold water fishery for Whitewood Creek. The water quality criteria are the parameters determined by the State to achieve the water quality objective. The effluent limitations, which are based on the water quality criteria, are the discharge parameters specified in the NPDES Discharge Permits.

STATE OF SOUTH DAKOTA REQUIREMENTS

WATER QUALITY OBJECTIVES AND STANDARDS

The State has established stream water quality objectives according to various beneficial use classifications. Ten of the classifications are listed in Table 2.2 with their identification numbers and definitions. The beneficial use categories assigned to streams in the study area are given in Table 2.3. The highest beneficial use designated for streams in the Lead-Deadwood area is a cold water permanent fishery, the water quality objective for Whitewood Creek.⁽¹⁾

Water quality standards specified by the State for the various beneficial use classifications are summarized in Table 2.4. These standards are published in the Rules of the Board of Environmental Protection, Article 34:04, Water Pollution Program, Chapter 34:04:02, entitled "Surface Water Quality

(1) Recent State action has changed the beneficial use for Whitewood Creek below Deadwood to a cold water marginal fishery, as explained in the Preface.

Table 2.1

EFFLUENT LIMITATIONS IN THE
NATIONAL POLLUTION DISCHARGE ELIMINATION SYSTEM DISCHARGE PERMITS
(unit mg/l except as noted)

<u>Parameter</u>	<u>Lead-Deadwood Sanitary District No. 1 (LDSD #1) SD-0020796</u>	<u>Combined LDSD #1-HMC SD-0020796</u>	<u>Homestake Mining Company (HMC) SD-0000043</u>
Permit No.			
BOD ₅			
Average	10	10	10
Maximum	17.5	17.5	17.5
Total Suspended Solids			
Average	10	10	10
Maximum	17.5	17.5	17.5
Fecal Coliform			
30-day Average MPN/100ml	200	200	-
7-day Average MPN/100ml	400	400	-
Total Residual Chlorine	0.05	0.05	0.02
Ammonia-Nitrogen	0.6	1.0	0.6
pH Units	6.0 - 9.0	6.0 - 9.0	6.5 - 9.0
Total Iron	-	0.3	0.3
Free Cyanide	-	0.008	0.005
Total Cyanide	-	0.03	0.02
Total Arsenic	-	0.16	0.1
Total Cadmium	-	0.005	0.003
Total Chromium	-	0.08	0.05
Total Copper	-	0.03	0.02
Total Lead	-	0.08	0.05
Dissolved Lead	-	0.022	0.015
Total Mercury	-	0.0003	0.0002
Total Nickel	-	0.31	0.2
Total Silver	-	0.0003	0.0002
Total Zinc	-	0.06	0.04
Oil and Grease	-	10.0	10.0
Undisassociated Hydrogen Sulfide	-	0.003	0.002

Table 2.2

BENEFICIAL USE CLASSIFICATIONS AND DEFINITIONS ⁽¹⁾

Stream Classification	Definition
1	"Domestic water supply," waters which are suitable for human consumption, culinary or food processing purposes, and other household purposes after suitable treatment by conventional processes.
2	"Cold water permanent fish life propagation," waters which are capable of supporting a permanent trout fishery from natural reproduction or fingerling stocking.
3	"Cold water marginal fish life propagation," waters which are suitable for supporting stockings of catchable size trout during portions of the year, but due to low flows, siltation, and warm temperature, are not suitable for a permanent cold water fish population.
4	"Warm water permanent fish life propagation," lakes and streams which are suitable for the permanent maintenance of warm water fish including walleyes, black bass, perch, channel catfish, northern pike, and bluegills.
5	"Warm water semipermanent fish life propagation," lakes and streams which are suitable for the maintenance of warm water fish (including walleyes, perch, black bass, northern pike, and channel catfish) but which suffer occasional fish kills because of critical natural conditions.
6	"Warm water marginal fish life propagation," lakes and streams which will support more tolerant species of fish with frequent stocking and intensive management but suffer frequent fish kills because of critical natural conditions.
7	"Immersion recreation," waters which are suitable for uses where the human body may come in direct contact with the water, to the point of complete submersion and where water may be ingested accidentally or certain sensitive organs such as the eyes, ears, and nose may be exposed to it.
8	"Limited contact recreation," waters which are suitable for boating, fishing, and other water related recreation other than immersion recreation.
9	"Wildlife propagation and stock watering," streams and lakes which are satisfactory as habitat for aquatic and semi-aquatic wild animals and fowl and are of suitable quality for watering domestic and wild animals.
10	"Irrigation," waters which are suitable for irrigating farm lands, ranch lands, gardens and recreational areas.

(1) From Rules of the Board of Environmental Protection,
Article 34:04, Water Pollution Program, State of South Dakota, 1974.

Table 2.3

BENEFICIAL USES DESIGNATED FOR
STREAMS WITHIN STUDY AREA (1) (2)

Stream	From	To	Beneficial Uses (3)
Whitewood Creek	Belle Fourche River	I-90 near City of Whitewood	5, 8
Whitewood Creek	I-90 near City of Whitewood	Northern Deadwood City Limits	2 ⁽⁴⁾ , 7, 8
Whitewood Creek	Northern Deadwood City Limits	Headwaters	2, 7, 8
Whitewood Creek (Identified as Englewood Creek in State Standards)	Confluence with Whitetail Creek	Headwaters	3, 8
Whitetail Creek (Identified as Kirk Creek in State Standards)	Whitewood Creek	Headwaters	3, 8
Grizzly Creek	Whitewood Creek	Headwaters	3, 8

(1) All streams within the State are assigned beneficial uses 9 and 10.

(2) Taken from Rules of the Board of Environmental Protection, Article 34:04,
Water Pollution Program. State of South Dakota, 1974.

(3) See Table 2.2 for definition of beneficial uses.

(4) This reach of Whitewood Creek has now been reclassified as a
cold water marginal fishery, or Beneficial Use Classification 3.

Table 2.4

Parameter	SOUTH DAKOTA SURFACE WATER QUALITY STANDARDS (1) (all values in mg/l unless otherwise noted)									
	Beneficial Use Classification/Concentration (2)									
	1	2	3	4	5	6	7	8	9	10
Total Residual Chlorine	-	0.020	0.020	0.020	0.020	0.020	-	-	-	-
Ammonia (Nitrogen)	-	0.600	1.000	1.000	1.000	1.500	-	-	-	-
Chlorides	-	100	-	-	-	-	-	-	-	-
Total Cyanide	-	0.020	0.020	0.020	0.020	0.020	-	-	-	-
Free Cyanide	-	0.005	0.005	0.005	0.005	0.005	5.000	5.000	-	-
DO (3)	-	6.000	5.000	5.000	5.000	5.000	-	-	-	-
Undissociated Hydrogen Sulfide	-	0.002	0.002	0.002	0.002	0.002	-	-	-	-
Total Suspended Solids (SS)	-	0.200	0.200	0.200	0.200	0.200	-	-	-	-
pH (6)	-	6.6-8.6	6.5-8.8	6.5-9.0	6.3-9.0	6.0-9.0	6.5-8.3	6.0-9.0	6.0-9.5	-
Temperature (°F)	-	30	90	90	90	150	-	-	-	-
Turbidity (JTU)	-	65	75	80	90	90	-	-	-	-
Coliform (MPN/100ml)	-	10	50	50	50	50	-	-	-	-
30-day Mean	5,000	-	-	-	-	-	1,000	5,000	-	5,000
Maximum	20,000	-	-	-	-	-	2,000	10,000	-	10,000
Fecal Coliform (MPN/100ml)	-	-	-	-	-	-	-	-	-	-
30-day Mean	-	-	-	-	-	-	200	1,000	-	1,000
Maximum	-	-	-	-	-	-	400	2,000	-	2,000
Total Alkalinity (CaCO ₃)	-	-	-	-	-	-	-	-	-	-
Total Dissolved Solids	1,000	-	-	-	-	-	-	-	-	-
Conductivity (micromhos/cm)	-	-	-	-	-	-	-	-	-	-
Nitrates (NO ₃)	10	-	-	-	-	-	-	-	2,500	1,500
Nitrate Adsorption Ratio	-	-	-	-	-	-	-	-	4,000	2,500
	-	-	-	-	-	-	-	-	50	10

(1) From Rules of the Board of Environmental Protection, Article 34:04, Water Pollution Program, State of South Dakota, 1974.

(2) Instream standards for uses 2 and 3 based on 25-year minimum, 7-day average flow; for use 5 they are based on 10-year minimum, 7-day average flow. Other use standards are not dependent on flow. Specific rules have been established that limit values in excess of standards that will be permitted.

(3) Spawning area, DO $\geq$ 7.0 mg/l during spawning season.

(4) Effluent limitation to trout fishery water must have an average BOD₅ and SS $\leq$ 10 mg/l and a maximum BOD₅ and SS $\leq$ 17.5 mg/l.

(5) Apply only from May 15 to September 30.

(6) Maximum instream pH change, 0.5.

Standards." The most stringent of the State requirements that the Facilities Plan alternatives must meet are those for a cold water fishery.

TOXIC MATERIALS

The "Surface Water Quality Standards" chapter also contains limitations on such items as (1) visible pollutants, (2) toxic materials, (3) radioactive iodine, radium, strontium, and tritium, (4) miscellaneous radionuclides, (5) dissolved gross beta radioactivity, (6) suspended radionuclides, (7) taste- and odor-producing chemicals, (8) nuisance aquatic life, (9) total dissolved gas, and (10) petroleum products. On the basis of available data, none of these items, except for toxic materials, should present a problem in wastewater management for the Lead-Deadwood planning area.

The limitations on toxic materials appear to be very strict for Whitewood Creek, including its tributaries, because it is classified as a cold water permanent fishery. The State Surface Water Quality Standards call for toxic limits to be based on median tolerance limits multiplied by an application factor of either 0.1 or 0.01, depending on the nature of the constituent under consideration. Median tolerance limits must be determined using bioassay tests simulating local stream conditions. The bioassay test required by the State of South Dakota Surface Water Quality Standards is a 96-hour acute toxicity bioassay analysis on the most sensitive local species, which is usually trout but may not be in the case of Whitewood Creek.

In lieu of the tests, the EPA and the State of South Dakota Department of Environmental Protection (DEP) completed a literature search to determine toxicity limits for various materials believed to be found in the wastewaters of the Lead-Deadwood area. Table 2.5 presents a list of toxic materials and estimated concentrations that would satisfy the State of South Dakota Surface Water Quality Standards. These concentrations were used by EPA to determine the toxic materials limitations in the proposed discharge permits for the District and HMC, as discussed in the next section.

Table 2.5

INSTREAM WATER QUALITY OBJECTIVES FOR TOXIC MATERIALS
NOT SPECIFIED IN THE SOUTH DAKOTA STATE STANDARDS

Parameter	Concentrations (mg/l)
Total Arsenic	0.1
Total Cadmium	0.03
Total Chromium	0.05
Total Copper	0.02 to 0.03
Total Lead	0.05
Total Dissolved Lead	0.014
Total Mercury	0.0002
Total Nickel	0.2
Total Silver	0.002
Total Zinc	0.04

After the proposed discharge permits were issued, EPA completed bioassay tests simulating actual stream conditions. As a result of those tests, some changes in the permits' toxic materials limitations have been suggested by EPA. The following conclusions and recommendations of the EPA bioassays are contained in the report "Evaluation of Proposed NPDES Permit Limitations for Homestake Mining Company and Lead-Deadwood Sanitary District No. 1" by the National Enforcement Investigations Center (Denver), dated February 1975:

CONCLUSIONS

1. The bioassays of the simulated waste of the Homestake Mining Company and the Lead-Deadwood Sanitary District No. 1 demonstrated that both effluents are potentially toxic to the degree that test fish were killed in 96 hours or less (acute toxicity). The results of these bioassays indicated that the proposed 1977 permit limitations for cyanide are not adequate. Acute toxicity occurred with cyanide concentrations of approximately 0.07 mg/l, three times greater than the proposed permit limitations. The proposed limitations cannot be expected to assure the survival and reproduction necessary to maintain a permanent coldwater fishery. Chronic exposure to cyanide concentrations of 0.02 mg/l has been shown to produce abnormal behavior in coldwater fishes.

2. The combined Homestake Mining Company and Lead-Deadwood Sanitary District No. 1 waste was considerably more toxic than the Homestake Mining Company simulated waste alone. The increased toxicity of this waste was attributed to the complexing of cyanide and chlorine to form highly toxic cyanogen chloride.

3. Both the "slime plant" and the "sand plant" effluents were acutely toxic at approximately the same cyanide concentrations as the simulated wastes. An effective concentration that killed 50 percent of the test fish (EC50) in the "slime plant" discharge test was determined to be a 0.07 percent concentration of effluent containing 0.07 mg/l total cyanide. No EC50 was estimated for the "sand plant" discharge; however, acute toxicity was observed at a 0.8 percent effluent concentration.

4. Analyses of bioassay results and supporting chemical data led to the conclusion that cyanide was the principal toxic agent. In all tests, fish kills were associated with total cyanide concentrations from 0.07 to 0.11 mg/l.

5. There was no indication that either heavy metals or un-ionized ammonia, at the levels specified in the 1977 permit, contributed to the toxicity of the waters tested. In fact, copper and iron limitations in the proposed 1977 permit are lower than the concentrations of these metals detected in Whitewood Creek, upstream from Gold Run, which supports a permanent coldwater fishery.

6. In situ exposure of rainbow trout demonstrated that the quality of Whitewood Creek upstream from the Gold Run confluence, its tributaries (Strawberry Creek and Grizzly Creek) and diverted Spearfish Creek were sufficient to support a coldwater fishery. Whitewood Creek downstream from the Gold Run discharge was extremely toxic to rainbow trout; all test fish died in less than 15 minutes of exposure. However, if the concentrations of pollutants discharged to Whitewood Creek at Gold Run were reduced to acceptable levels, Whitewood Creek downstream from this point could support a coldwater fishery.

RECOMMENDATIONS

To improve the water quality of Whitewood Creek sufficiently to establish a coldwater fishery and assure the protection of aquatic biota, the following recommendations are made for the Homestake Mining Company and the Lead-Deadwood Sanitary District No. 1 discharges:

1. Total cyanide concentrations shall not exceed 0.005 mg/l (1/20 EC50). In the absence of analytical procedures having detection limits in this range, total cyanide concentrations shall be limited to the presently detectable limit of 0.02 mg/l.

2. To prevent the formation of cyanogen chloride, effluents containing cyanide shall not be combined with wastewaters containing residual chlorine.

3. Heavy metal concentrations as proposed in permits No. SD0000043 and No. SD0020796 shall be implemented in the final NPDES permits.

4. Total ammonia and residual chlorine levels shall be adopted in the final NPDES permits as stated in the proposed limitations, providing recommendations 1 through 3 of this document have been met.

Subsequent to the February report, the National Enforcement Investigations Center (Denver) conducted continuous-flow acute bioassays on nine metals for which effluent limitations had been proposed in the HMC NPDES permit. Their report, "Evaluation of Proposed NPDES Permit Limitations for Homestake Mining Company" (August 1975), made the following recommendations:

RECOMMENDATIONS

The following recommendations are made in accordance with South Dakota Water Quality Standards for the discharge of residual and accumulative substances, and to assure the protection of a coldwater fishery in Whitewood Creek.

Heavy metal effluent limitations in Homestake Mining Company permit No. SD-0000043 should be revised to read:

1. Total cadmium concentrations shall not exceed 0.07 µg/l (1/100 EC50).
2. Total copper concentrations shall not exceed 2.5 µg/l (1/100 EC50).
3. Total zinc concentrations shall not exceed 5.5 µg/l (1/100 EC50).
4. Total chromium concentrations shall not exceed 240 µg/l (1/100 EC50).
5. Total lead concentrations shall not exceed 80 µg/l (1/100 EC50).
6. Total mercury concentrations shall not exceed 0.3 µg/l (1/100 EC50).
7. Total nickel concentrations shall not exceed 350 µg/l (1/100 EC50).

8. Total silver concentrations shall not exceed 0.3 $\mu\text{g/l}$ (1/100 EC50).

The effluent limitation of 100 $\mu\text{g/l}$ for arsenic is adequate as listed in NPDES permit No. SD-0000043.

A summary of the bioassay results compared with the proposed effluent limitations is presented in Table 2.6, taken from the National Enforcement Investigations Center (Denver) report.

NPDES DISCHARGE PERMITS

The District and HMC have been issued discharge permits in compliance with provisions of the Federal Water Pollution Control Act as amended in 1972 by Region VIII, EPA, as presented earlier in Table 2.1. The limitations are based on the EPA's interpretation of the South Dakota Surface Water Quality Standards. Thus, the Permits have been set with the objective of achieving the high water quality necessary to establish a cold water fishery in Whitewood Creek.

To determine the effluent limitations, the EPA adjusted South Dakota's standards to reflect the quality and quantity of dilution water believed to be available in Whitewood Creek drainage basin. Because of the limited hydrologic data on the Creek, both its flow and background quality had to be estimated to establish the effluent limitations.

The flow records available for Whitewood Creek drainage basin are greatly influenced by the inter-basin and intra-basin water diversions. A lack of well-coordinated flow data prevents a definitive analysis of the basin's hydrology. The EPA estimated the 25-year, 7-day low mean discharge for Whitewood Creek from flow records available on Spearfish Creek. Spearfish Creek lies immediately west of the study area and has excellent flow records. The flows for the Whitewood Creek drainage area were determined by multiplying a ratio of the two drainage basins' areas times the Spearfish Creek flows. This is the best method available for estimating Whitewood Creek's flow without performing an expensive and time-consuming study. The calculation yielded an estimated 25-year, 7-day low mean flow of 4.5 cubic feet per second (cfs) in Whitewood Creek at Pluma. The flow was estimated at 6.67 cfs below the confluence of Spruce Gulch and Whitewood Creek and at 8.79 cfs near Cook City.

The background water quality used to establish the effluent limitations also had to be approximated. Although a large

Table 2.6

SUMMARY OF 96-HOUR BIOASSAY RESULTS
COMPARED WITH EFFLUENT LIMITATIONS PROPOSED FOR
NPDES PERMIT NO. SD-0000043 (1) (2)

Toxicant	Compound Tested	Test Concentration Range	Effluent Limitations		
			EC50	EC50 x 0.01 (3)	Permit No. SD-0000043
As	sodium arsenite NaAsO_2	2,310-37,000	10,800	108	100
Cd	cadmium nitrate $\text{Cd}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$	1.8-28	6.6	0.07	3.0
Cr	chromium nitrate $\text{Cr}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$	4,020-64,250	24,090	241	50
Cu	cupric nitrate $\text{Cu}(\text{NO}_3)_2$	78-1,250	253	2.5	20
Pb	lead nitrate $\text{Pb}(\text{NO}_3)_2$	875-14,000	8,000	80	50
Hg	mercurous nitrate $\text{Hg}(\text{NO}_3)_2 \cdot \text{H}_2\text{O}$	22.9-367	33	0.3	0.2
Ni	nickel nitrate $\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	6,110-97,750	35,500	355	200
Ag	silver nitrate AgNO_3	5-80	28.8	0.3	0.2
Zn	zinc acetate $\text{Zn}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 2\text{H}_2\text{O}$	66-1,053	550	5.5	40

Adequacy of Limitation
in Permit No. SD-0000043

Adequate

Lenient

Stringent

Lenient

Stringent

Stringent

Stringent

Stringent

Lenient

(1) From "Evaluation of Proposed NPDES Permit Limitations for Homestake Mining Company," National Enforcement Investigations Center, Denver, Colorado, August 1975.

(2) Concentrations in $\mu\text{g/l}$ of the element.

(3) South Dakota Water Quality Standards prohibit the discharge of any material which produces concentrations of chemicals greater than 0.1 times the median tolerance limit (96-hr) for short residual compounds, and 0.1 times the median tolerance limit for accumulative substances or substances with residual life greater than 30 days in the receiving water. Because the toxicants tested are either accumulative or would have residual lives greater than 30 days, an application factor of 0.01 was used for calculation of effluent limitations.

amount of data has been collected concerning the background water qualities of the area streams, characterizations including the magnitude and frequency of quality variations are not available. With few exceptions, the analytical data are based on grab samples taken at random points in the stream throughout the year. These data show a wide variation in water quality. Data recently taken by the State indicate that the water quality in Whitewood Creek above Gold Run, which receives the major discharges from Lead and HMC, does not meet several of the criteria established for the protection of a cold water fishery. Thus, the fishery objective may not be feasible under these conditions.

Another unknown factor affecting the establishment of a cold water fishery in Whitewood Creek is the impact of the existing tailings deposits in, and adjacent to, the stream. The regulatory agencies have assumed that in time Whitewood Creek would fully recover, given proper conditions, to support a cold water fishery. However, the amount of time necessary for the stream to purge itself of old tailings deposits has not been estimated. The potential of the old tailings deposits to prevent the establishment of a cold water fishery should be evaluated.

Due to these uncertainties about the stream's hydrologic data and the effect of existing deposits, there is reasonable doubt that achieving the effluent limitations would establish a cold water fishery.

FEDERAL REQUIREMENTS

BEST PRACTICABLE WASTEWATER TREATMENT TECHNOLOGY (BPWTT)

The Federal Water Pollution Control Act Amendments of 1972 require evaluation of alternative wastewater treatment systems to achieve BPWTT. On 25 March 1974, the EPA published a draft of the proposed BPWTT guidelines. This information is summarized in Table 2.7. All publicly owned treatment works must meet BPWTT requirements by 1 July 1983. Those treatment works receiving grant funds authorized after 30 June 1974 must be designed in a manner that will allow for the addition of other unit processes needed to achieve BPWTT. These unit processes will not be required until BPWTT becomes effective on 1 July 1983.

According to the current definition of BPWTT, Whitewood Creek is classified as a "water quality segment" (Table 2.7). Thus, to be eligible for Federal support, the wastewater management project implemented in the study area must provide a minimum of secondary treatment.

Table 2.7

PROPOSED DEFINITION OF
BEST PRACTICABLE WASTEWATER TREATMENT TECHNOLOGY BY EPA ⁽¹⁾

I. Alternatives Employing Treatment and Discharge into Navigable Waters

A. Effluent limited segments

• Secondary treatment

	Unit of Measurement	Monthly Average	Weekly Average
Biochemical Oxygen Demand (5-day)	mg/l	30	45
Suspended Solids	mg/l	30	45
Fecal Coliform Bacteria	MPN/100ml	200	400
pH	unit	6.0 to 9.0	

B. Water quality segments

• Minimum of secondary treatment

• State may set more restrictive standards

II. Alternatives Employing Land Application Techniques and Land Utilization Practices

A. System with underdrain resulting in point discharge, same as above

B. System in which water will reach the ground water system must meet EPA drinking water standards

(1) Subject to revision pending adoption of final standards by EPA.

If a land application system is adopted, it must meet BPWTT standards for land and surface disposal. These standards were developed to assure that potable ground water sources will remain suitable for drinking water. Any wastewater reaching a ground water source must meet Federal drinking water standards and the EPA pesticide levels for drinking water. Any water collected in an underdrain system and discharged into a stream must comply with the above requirements for either an effluent or water quality segment, depending on the receiving water's classification.

The definition of BPWTT also states that reuse of water shall not result in additional pollutants over the level designated in BPWTT for discharges directly into navigable waters or for wastewaters reaching ground water sources.

These standards are preliminary because the EPA has not formally adopted a definition of BPWTT. The definition presented in Table 2.7 is the second one that the EPA has published for comment. The final BPWTT definition may vary significantly from that published in this report.

TOXIC MATERIALS

Public Law 92-500 provides for the establishment of toxic pollutant limitations by the EPA. These limitations are primarily applicable in determining restrictions for industrial discharges. To date, the limitations are only proposed and have not been considered in estimating the NPDES Discharge Permits' effluent limitations. These Federal toxic standards are presented here because once adopted, they could further restrict industrial discharges.

Table 2.8 lists the three toxic substances included in the proposed standards. Additional standards will be added as the technology for establishing them is developed.

Three types of standards are given in Table 2.8. The first is acute toxicity, which can be assumed to be the maximum allowable concentration for a short period of time. The chronic toxicity standards represent the average values that will protect aquatic life over an extended exposure to a toxic material. The maximum loading is derived from the chronic standards and takes into consideration the flow of the receiving stream. These daily loading figures are multiplied by the flow of a particular stream to determine the maximum loading allowed for that stream. The allowable discharge is designed to provide protection against chronic toxicity.

Table 2.8

PROPOSED TOXIC POLLUTANT EFFLUENT STANDARDS
FOR FRESH WATER⁽¹⁾

	Acute Toxicity (mg/l)	Chronic Toxicity (mg/l)	Maximum Daily Loading (lbs/day/cfs)
Cadmium (soft water) ⁽²⁾	0.07	0.0004	0.0022
(hard water) ⁽³⁾	2.00	0.003	0.016
Cyanide	0.10	0.005	0.027
Mercury	0.05	0.00005	0.00027

(1) From "Advance Notice of Proposed Rulemaking for Toxic Pollutant Effluent Standards," EPA, 10 December 1974.

(2) Soft Water -- $\text{CaCO}_3 < 100 \text{ mg/l}$.

(3) Hard Water -- $\text{CaCO}_3 > 100 \text{ mg/l}$.

Presented in Table 2.9 is the maximum discharge for the three toxic materials allowed by the proposed Federal Toxic Pollutant Effluent Standards for two points on Whitewood Creek. The streamflow associated with these standards is defined by the EPA as the 5-year, 30-day mean low flow. The flow for Whitewood Creek was estimated using the procedures developed by the EPA and used in the development of the NPDES discharge effluent limitations, as previously explained.

Table 2.9

MAXIMUM ALLOWABLE DAILY DISCHARGE OF TOXIC MATERIAL

	Maximum Daily Loading (1) (lbs/day/cfs)	Whitewood Creek	
		At Pluma (2) (lbs/day)	At Lower Deadwood (3) (lbs/day)
Cadmium (soft water)	0.0022	0.01	0.02
(hard water)	0.016	0.1	0.14
Cyanide	0.027	0.16	0.24
Mercury	0.00027	0.0016	0.0024

- (1) From "Advance Notice of Proposed Rulemaking for Toxic Pollutant Effluent Standards," EPA, 10 December 1974.
- (2) Based on 5-year, 30-day mean low flow for Spearfish Creek plus the 7 cfs estimated as Homestake Mining Company historical diversions, adjusted by the ratio of the drainage basin areas. This procedure (used by EPA to estimate 25-year, 7-day low mean flow in NPDES Discharge Permit) yields a 5-year, 30-day mean low flow of 6 cfs.
- (3) See note (2) above. This procedure yielded a 5-year, 30-day mean low flow of 8.9 cfs.

Chapter 3
SUMMARY OF POLLUTION SOURCES, ESTIMATED
WASTE LOADS, AND WATER QUALITY

The Lead-Deadwood area discharges its wastes into Whitewood Creek and its tributaries. These discharges have not only a local, but also a regional impact. Effects of the study area's pollution have been measured as far as 110 miles downstream, along the Belle Fourche River, shown on Figure 3.1. This chapter examines the study area's pollution sources, current and projected municipal and industrial waste loads, and the water quality of area streams both above and below the major discharge points.

LOCATION OF MUNICIPAL AND INDUSTRIAL WASTE SOURCES

The pollution sources within the Lead-Deadwood area are identified on Figure 3.2. The area's three major untreated wastewater discharge sources are the City of Deadwood, the City of Lead, and HMC. There are also numerous minor pollution sources from commercial, industrial, and domestic developments that are not presently connected to a local or centralized sewer system. These systems are shown by the shaded areas on Figure 3.2.

The City of Deadwood has separate sanitary and storm water collection systems. The storm water is discharged into Deadwood Creek and Whitewood Creek. The sanitary sewer system discharges untreated flows into Whitewood Creek downstream from Deadwood's rodeo grounds. Deadwood also has several separate wastewater discharges into City Creek and Whitewood Creek. These small individual discharges are near Cliff Street and the rodeo grounds.

The City of Lead has a combined sewer system for collecting domestic, commercial and industrial wastewater and storm water. This collection system discharges untreated flows into Gold Run Creek. Several locations within Lead are not connected with the centralized combined sewer system. These locations presently have waste streams that either receive no treatment or undergo treatment in Imhoff tanks or septic tanks.

The third major pollution source in the Lead-Deadwood area is the discharge of tailings and industrial waste from HMC. HMC's waste is the area's largest suspended solids, cyanide, and heavy metals pollution source. At present, HMC discharges approximately 2,700 tons to 3,000 tons per day of tailings.

Most of the mine's wastes are discharged into either the lower reaches of the Lead combined collection system near HMC's sand

plant or Gold Run Creek. Figure 3.3, based on information from HMC, indicates the location of waste streams that are combined with Lead's flows near the sand plant. These waste streams include industrial flows from the HMC settling ponds, slime plant, and sand dams in addition to domestic flows from residences located on or near Enos Street.

The five outlying areas of Deadwood Creek, Grizzly Gulch/Strawberry Creek, Nevada Gulch/Fantail Creek, Terry Peak/Bald Mountain and Deer Mountain are minor sources of water pollution. These areas are presently unsewered, with septage and untreated wastewater being discharged into the area streams. The Lawrence County Sanitarian has identified the first three of these areas as "areas of public health concern."

Other scattered areas with separate discharges along roadways and streams are not developed enough at this time to have any impact on the area's pollution problem.

WASTE LOADS

MUNICIPAL WASTE LOADS

Based on projected population, economic growth, and land use patterns, future municipal waste loads are not expected to differ significantly from current levels. A previous CH2M Hill report entitled "Basinwide Environmental Overview" contains detailed descriptions of the study area's present and projected socioeconomic conditions. That report concluded that by the end of the planning period of 1995 the area should experience little population change, moderate economic growth, and basically unchanged land use patterns.

The population figures presented in the "Basinwide Environmental Overview" were used to estimate the area's waste loads. Table 3.1 is a summary of the estimated 1995 wastewater flows and characteristics. A limited wastewater sampling program was performed to measure current waste loads for various constituents and flow rates. The waste loads and flow rates calculated from the sampling program data were expressed on a per capita basis using a current population figure for the study area. These per capita figures were also adjusted to reflect the dilution caused by the existing inflow/infiltration. The per capita amounts are shown in Table 3.1. These per capita figures were multiplied by 1995 population estimates (for each discharge system) to derive the system's 1995 projected daily waste load for each constituent.

For those discharge sources that have collection systems, the projected 1995 waste loads and flows, as shown in Table 3.1, are based on data from the inflow/infiltration study completed

Table 3.1
ESTIMATED 1995 WASTEWATER LOADS

Parameter	1995 Population Equivalent	Flow	COO	BOD	Kjeldahl Nitrogen	NH ₃ -N	NO ₂ -N	NO ₃ -N	PO ₄ -P	Oil and Grease	Total Solids	TSS	TSS
lb/cap/day	W/A	100 gal/cap/day gal/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day	lb/day
SUBSYSTEMS													
Cliff Street Collection System	165	16,500	68	28	12	7	0	0	2	45	366	47	20
Deadwood City	3,319	591,000 (1)	1,161	564	239	136	10	50	50	909	7,362	939	395
Grizzly Gulch - Strawberry Creek Collection System	140	14,000	57	24	10	6	0	2	2	38	311	40	17
Lead City	5,110	(1,140,000)	2,095	869	368	210	15	77	77	1,400	11,344	1,466	608
(Alternate A)		(780,000)											
(Alternate D)		(1,520,000)											
(Alternate E)		(27,000 (2))	82	34	14	8	1	3	3	55	444	57	24
North Washington Street Pluma Collection System	200	2,000	8	3	1	1	0	0	0	5	44	6	2
DEADWOOD CREEK SYSTEM													
Blacktail Gulch Collection System	185	18,500	76	31	13	8	1	3	3	51	410	52	22
Central City Collection System	330	33,000	135	56	24	14	1	5	5	90	732	91	39
Deadwood Creek Interceptor	40	4,000	16	7	3	2	0	1	1	11	89	34	5
Glendale Collection System	200	24,600 (2)	82	34	14	8	1	3	3	55	444	170	24
Terraville Collection System	100	10,000	41	17	7	4	0	2	2	27	222	28	11
WEST OUTFRINGS													
Canyon Street Branch	210	28,400	86	36	15	9	1	3	3	58	466	179	25
Fentail Branch	60	6,000	25	10	4	3	0	1	1	16	133	51	7
Lower Whitetail Interceptor	---	---	---	---	---	---	---	---	---	---	---	---	---
Matthew Street Branch	85	11,500 (2)	35	14	6	4	0	1	1	23	189	72	10
Middle Whitetail Interceptor	55	5,500	23	9	4	2	0	1	1	15	122	47	7
Middle Whitewood Interceptor	---	---	---	---	---	---	---	---	---	---	---	---	---
Neveda Gulch Branch	200	20,000 (2)	82	34	14	8	1	3	3	55	444	170	24
Pavilion Street Branch	15	2,000 (2)	6	3	1	1	0	0	0	4	31	13	2
Ross Shaft Branch	---	---	---	---	---	---	---	---	---	---	---	---	---
South Main Branch	145	40,000 (2)	59	25	10	6	0	2	2	40	322	41	17
Upper Whitetail Branch	70	19,600 (2)	29	12	5	3	0	1	1	19	155	20	8
TOTALS			4,366	1,835	764	440	31	160	160	2,916	23,632	3,034	1,268

(1) Based on field measurements.

(2) Based on 135 gallons per capita per day to allow for inflow/infiltration.

for this project. It was assumed that the undeveloped sub-systems would have new collection facilities by 1995, which would minimize the inflow/infiltration effects. New population served by these collection systems was assumed to produce 100 gallons of wastewater per capita per day.

INDUSTRIAL WASTE LOADS

HMC's waste loads were determined in the Facilities Plan Task 13 study, "Development and Evaluation of Industrial Waste Treatment Alternatives," CH2M Hill, May 1975. As part of that task the following information was developed:

- Schematic diagram of water flow through HMC's mill.
- Water use balances for the various processes and the total milling process.
- Water quality measurements of selected process streams through sampling and testing.

From the determined water balances and water quality testing results, the present waste loads discharged by HMC were developed. These waste loads were separated into the following five point sources:

- Slime plant tails
- Sand dam tails
- Presshouse tank overflow
- Settling dam overflow
- Sand vat bottom discharge

Table 3.2 presents the constituent analysis and waste loads from these five process streams, as well as the total waste loads discharged by HMC.

Total estimated flow from the HMC waste sources is 3,462 gpm. The total estimated flow discharged from the mill is 4,011 gpm. Because 165 gpm is used to sluice sand to the stopes, a net discharge into Whitewood Creek of 3,846 gpm (5.54 mgd) is estimated. The difference between the flow from the point sources and the net discharge is 384 gpm. This flow is mainly composed of cooling water.

To estimate future industrial waste loads, potential flow reduction due to planned water recycling and the effects of pretreating HMC's wastes must be considered. Exact future loads cannot be determined until the recycling and pretreatment systems are defined.

Table 3.2
EXISTING HOMESTAKE MINING COMPANY WASTEWATER DISCHARGE LOADS

Constituent	Slime Tails (Str. No. 60)	Sand Dam Tails ⁽¹⁾	Presshouse Tank Overflow (Str. No. 34)	Settling Dam Overflow (Str. No. 28)	Vat Underflow (Str. No. 38 and 53)	BNC Total
	mg/l (1)	lb/day	mg/l	lb/day	mg/l	lb/day
Sulfides	.002-.8	.48	<.002	--	<.002	3.5 145.5
Cr	<.05	--	<.05	--	<.05	--
Hg	0.001	.0048	0.001	0.014	0.002	0.071
Mn	0.1	0.5	<.05	--	<.05	1.04
As	1.3	6.3	0.2	2.9	0.15	12.63
Cd	<.01	--	<.01	--	<.01	0.07
Cu	5.0	24.2	0.05	0.7	1.2	66.0
Mo ₃ -W	1-3	9.6	1.1-3	2.9	2.0	91.3
Fe	6-12	43.5	8	115	0.3	207.0
Total Pb	<.01	--	<.01	--	<.01	1.95
Dissolved Pb	<.01	--	<.01	--	<.01	--
Ni	0.05	.24	0.01	0.14	0.01	4.82
Zn	8-16	58	0.3	0.43	0.5	63.6
BOO ₅	59	285	2	28.8	<5	313.8
Total CN	95	460	.165	2.3	0.52	571
Suspended Solids	40	193	96	1,385	5	--
Total Solids			1,600	23,000	800	--
pH	8.6	8.5	7.8	10.7	11.0	--
Tails	2,400 ⁽²⁾ tons/day	600 ⁽³⁾ tons/day				3,000 tons/day
Estimated Flow	400 gpm 0.58 mgd	910 gpm ⁽³⁾ 1.31 mgd	1,200 gpm 1.73 mgd	800 gpm 1.15 mgd	152 gpm 0.22 mgd	3,462 gpm ⁽⁵⁾ 4.99 mgd

(1) Concentrations are based on decanted tails sample.

(2) Future slime tails could reach 3,000 tons/day if the Bald Mountain Mine is included.

(3) After sluicing of sand back to stope.

(4) Sand dam tails is made up of several other streamflows. Does not have a stream number.

(5) Total water discharged from the mill is 4,011 gpm. The remaining 549 gpm is uncontaminated cooling water and water used to sluice sand to the stope.

Table 3.2
EXISTING HOMESTAKE MINING COMPANY WASTEWATER DISCHARGE LOADS

Constituent	Slime Tails (Str. No. 60)	Sand Dam Tails (1)	Preshouse Tank Overflow (Str. No. 34)	Settling Dam Overflow (Str. No. 28)	Vat Underflow (Str. No. 38 and 51)	PMC Total
	mg/l (1)	lb/day	mg/l	lb/day	mg/l	lb/day
Sulfides	.002-.8	.48	<.002	--	<.002	--
Cr	<.05	--	<.05	--	<.05	--
Hg	0.001	.0048	0.001	0.014	0.002	0.071
Ni	0.1	0.5	<.05	--	<.05	1.04
As	1.3	6.3	0.2	2.9	0.15	12.63
Cd	<.01	--	<.01	--	<.01	0.07
Cu	5.0	24.2	0.05	0.7	1.2	66.0
Mn	1-3	9.6	1-3	2.9	2.0	91.3
Fe	6-12	43.5	8	115	0.3	207.0
Total Pb	<.01	--	<.01	0.09	<.01	1.95
Dissolved Pb	<.01	--	<.01	--	<.01	--
Ag	0.05	.24	0.01	0.14	0.01	4.82
Zn	8-16	58	0.3	0.43	0.5	63.6
MO ₅	59	285	2	28.8	<5	313.8
Total CW	95	460	.165	2.3	5.0	571
Suspended Solids	40	193	96	1,385	5	--
Total Solids			1,600	23,000	800	--
pH	8.6		7.8	10.7	11.0	--
Tails	2,400 (2) tons/day	600 (3) tons/day				3,000 tons/day
Estimated Flow	400 gpm 0.58 mgd	910 gpm (3) 1.31 mgd	1,200 gpm 1.73 mgd	800 gpm 1.15 mgd	152 gpm 0.22 mgd	3,462 gpm (5) 4.99 mgd

(1) Concentrations are based on decanted tailings sample.

(2) Future slime tails could reach 1,000 tons/day if the Bald Mountain Mine is included.

(3) After sluicing of sand back to stopes.

(4) Sand dam tails is made up of several other streamflows. Does not have a stream number.

(5) Total water discharged from the mill is 4,011 gpm. The remaining 549 gpm is uncontaminated cooling water and water used to sluice sand to the stopes.

In this Facilities Plan, a recycling system capable of reducing flows to 1 mgd has been assumed. A minimum pretreatment of alkaline chlorination for cyanide removal has also been assumed. Additional processes, including chemical coagulation, sedimentation, and filtration, may also be required, depending on the wastewater management alternative selected.

Regardless of the alternative treatment system, HMC's loadings to the system are assumed to originate from a proposed tailings pond to be located in Grizzly Gulch. Tailings decant would be delivered to the treatment site. The assumed loadings to the treatment system are given below for untreated wastewater.

Flow	1.0 mgd (700 gpm)
Average Cyanide	180 lbs/day
Maximum Cyanide	500 lbs/day

This flow is based on the water returned from the tailings pond which is not reused to sluice sand tails to the tailings pond. When the additional processes are included in the pretreatment, the influent flow to the system increases from 1.0 to 1.3 mgd (900 gpm), due to return flows from the chemical clarifier and filtration processes.

The average loading given above assumes some cyanide reduction would occur in the tailings pond during the warmer months as a result of oxidation and volatilization. Evidence reported in the Facilities Plan Task 13 study indicates cyanide removals of up to 90% can be achieved in open water impoundments by these natural phenomena. The maximum cyanide loading is expected during the winter months, when an ice cover on the tailings pond would prevent oxidation and volatilization of cyanide.

STORM WATER

Storm flows for the study area have not been measured. However, the inflow estimates in Table 3.3 have been made for Lead. Storm flows have not been estimated for Deadwood.

Storm water quality can be extremely variable, as shown in Table 3.4. The characteristics of storm water should be determined by a monitoring program which would measure flow and wet weather water quality parameters.

WATER QUALITY OF RECEIVING STREAMS

Many studies have been made of the water quality of the streams in the study area. However, the water quality data are incomplete and variable. Tables 3.5 and 3.6 summarize the water quality data compiled in previous studies.

Table 3.3

ASSUMED INFLOW PARAMETERS

<u>Storm Frequency (years)</u>	<u>Storm Duration (hours)</u>	<u>Peak Flow Rate (mgd)</u>	<u>24-Hour Volume (million gallons)</u>	<u>Average Annual Flow Rate (mgd)</u>
2	24	177	9.88	-
5	24	268	14.66	-
10	24	370	20.20	0.75
25	24	478	26.07	-

Note: The average annual flow rate for all storms is 0.3 mgd.

* * * * *

Table 3.4⁽¹⁾

POLLUTION FROM URBAN AND AGRICULTURAL RUNOFF

<u>Constituent</u>	<u>Urban Runoff (Storm Water)</u>	<u>Agricultural Runoff</u>
Suspended Solids, mg/l	5 - 1,200	-
Chemical Oxygen Demand (COD), mg/l	20 - 610	-
Biological Oxygen Demand (BOD), mg/l	1 - 173	-
Total Phosphorus, mg/l	0.02 - 7.3	0.1 - 0.65
Nitrate-Nitrogen, mg/l	-	0.03 - 5.0
Total Nitrogen, mg/l	0.3 - 7.5	0.5 - 6.5
Chlorides, mg/l	3 - 35	-

(1) W. W. Eckenfelder, Jr., Water Quality Engineering for
Practicing Engineers, 1970.

Table 3.5

EXISTING STREAM QUALITY DATA UPSTREAM OF
HOMESTAKE MINING COMPANY AND MUNICIPAL DISCHARGES⁽¹⁾

Parameter	Whitewood Creek Above Fluma			Whitewood Creek Above Whitetail Creek		Whitetail Creek Above Deadwood Creek		Grizzly Gulch Creek	
	Source A	Source B	Source C	Source A	Source A	Source B	Source B	Source D	Source D
Total Suspended Solids	6	--	--	1	3-6	--	--	0	--
Total Iron	0.16	0.9-5.3	0.26	0.14	0.77-0.78	0.31-0.5	--	<0.01	--
Total Cyanide	N.D. (2)	<0.02	--	N.D.	N.D.	<0.02	--	--	--
Total Arsenic	--	0.013-1.0	0.01	--	--	0.0084-0.012	--	--	--
Total Cadmium	--	0.002-0.05	--	--	--	0.001-0.05	--	<0.01	--
Total Chromium	--	--	N.D.	--	--	--	--	<0.02	--
Total Copper	--	0-0.03	0.15	--	--	0-0.01	--	<0.02	--
Total Lead	--	0-0.56	N.D.	--	--	<0.2-0.65	--	<0.10	--
Total Mercury	--	0.0002-0.0017	0.0013	--	--	<0.0002-0.0014	--	<0.2	--
Total Nickel	--	--	N.D.	--	--	--	--	<0.03	--
Total Zinc	--	<0.02-0.08	0.13	--	--	<0.01-1.11	--	<0.001-0.007	--
pH (units)	7.8	--	--	7.8	7.3-7.7	--	--	7.51-7.70	--
Turbidity (JTU)	5	--	--	7	7-8	--	--	--	--
Chloride	120	--	1	175	102-157	--	--	4.59-5.67	--
Manganese	--	--	N.D.	--	--	--	--	--	--
Molybdenum	--	--	N.D.	--	--	--	--	--	--

(1) Sample results are in mg/l unless otherwise noted and are taken from the following sources:

A An Evaluation of Pollution in the Belle Fourche and Cheyenne Rivers Due to Wastes Carried by Whitewood Creek. C. A. Thilenius, 1965.
Grab sampled February 1963. Results in ppm.

B Report on Pollution Affecting Water Quality of Cheyenne River System, EPA, 1971. Grab sampled March and June 1971.

C Investigations of Gold Run Creek Outfall Water. Colorado School of Mines Research Institute, 1974. Grab sampled October 1973.
Filtered: 0.45u.

D Grizzly Gulch Supportive Data. CH2M HILL, 1974. Grab sampled October 1974.

(2) Not detected.

Table 3-6

EXISTING STREAM QUALITY DATA DOWNSTREAM OF
HOMESTEAD MINING COMPANY AND MUNICIPAL DISCHARGES (1)

Parameter	Gold Run Creek Above Whitewood Creek		Whitewood Creek In Lower Deadwood Area		Whitewood Creek Near Whitewood Source A
	Source A	Source C	Source A	Source B	Source C
NO ₃	25-70	--	10-100	--	--
Total Suspended Solids	804	--	12,570-15,466	--	--
Total Iron	--	N.D. (2)	--	225-428	N.D.
Total Cyanide	0.6-9.1	--	0.69-2.1	0.50-1.1	--
Total Arsenic	--	0.14	--	0.23-1.70	0.69
Total Cadmium	--	--	--	0.003-<0.05	--
Total Chromium	--	N.D.	--	--	--
Total Copper	--	1.3	--	0.11-0.18	0.03
Total Lead	--	N.D.	--	<0.2-0.70	N.D.
Total Mercury	--	0.001	--	0.0021-0.0080	--
Total Nickel	--	0.02	--	--	--
Total Zinc	--	0.026	--	0.45-0.60	0.015
pH (units)	8.0-11.7	--	6.4-8.8	--	8.2-8.4
Dissolved Oxygen	4.7-6.1	--	1.5-3.7	--	--
Temperature (°F)	61-63	--	61-72	--	69-77
Manganese	--	N.D.	--	--	--
Molybdenum	--	0.013	--	--	0.02
Fecal Coliforms (No./100ml)	2.4(10) ⁶ -46(10) ⁶	--	0.43(10) ⁶ -11(10) ⁶	--	N.D.

(1) Sample results are in mg/l unless otherwise noted and are taken from the following sources:

A Report of Water Pollution Studies, Gold Run Creek-Whitewood Creek, Belle Fourche River-Cheyenne River. South Dakota State Department of Health, 1960. Composite sampled June and July 1959. Results in ppm.

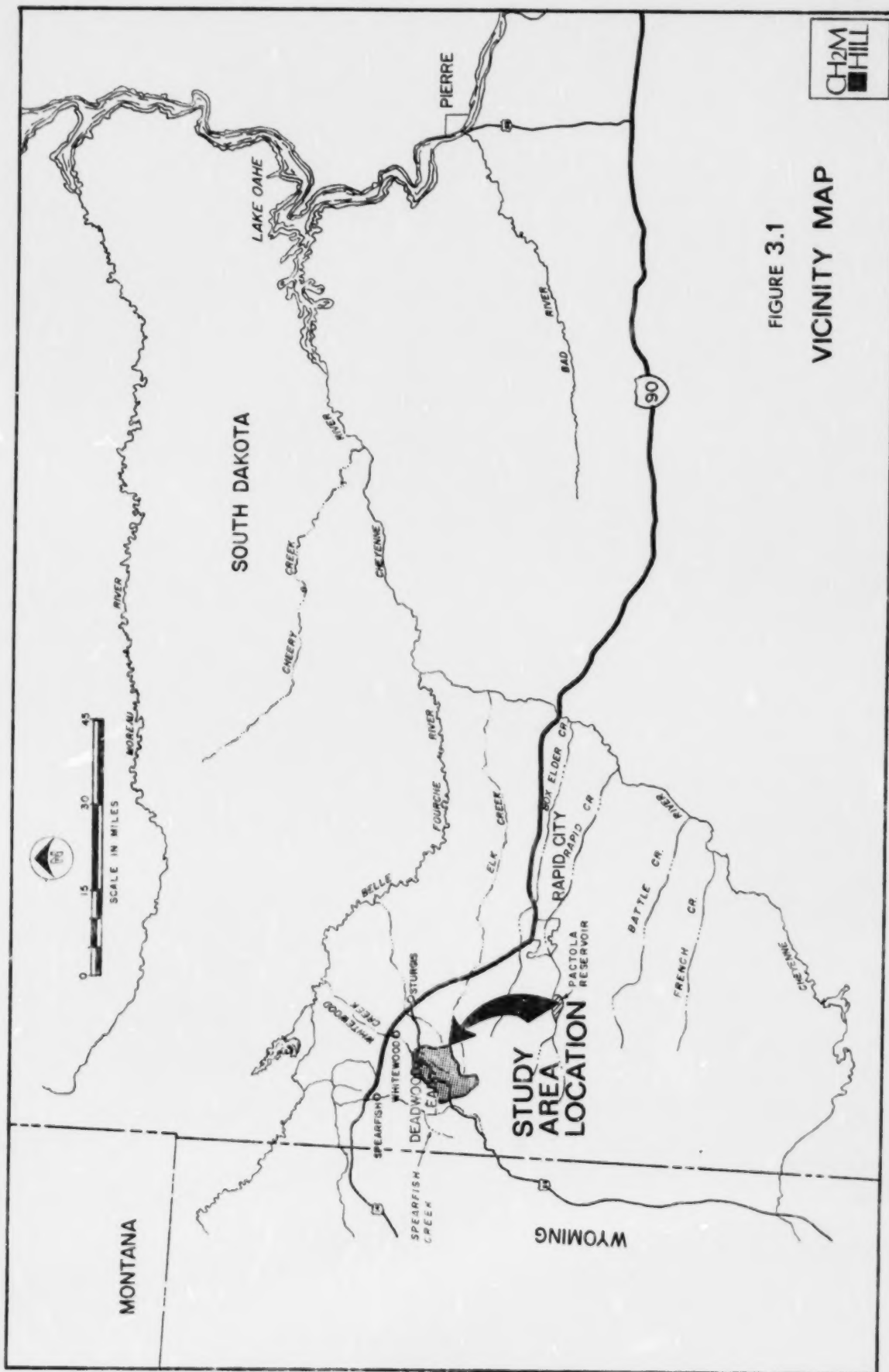
B Report on Pollution Affecting Water Quality of Cheyenne River System. EPA, 1971. Composite sampled March, June, and July 1971.

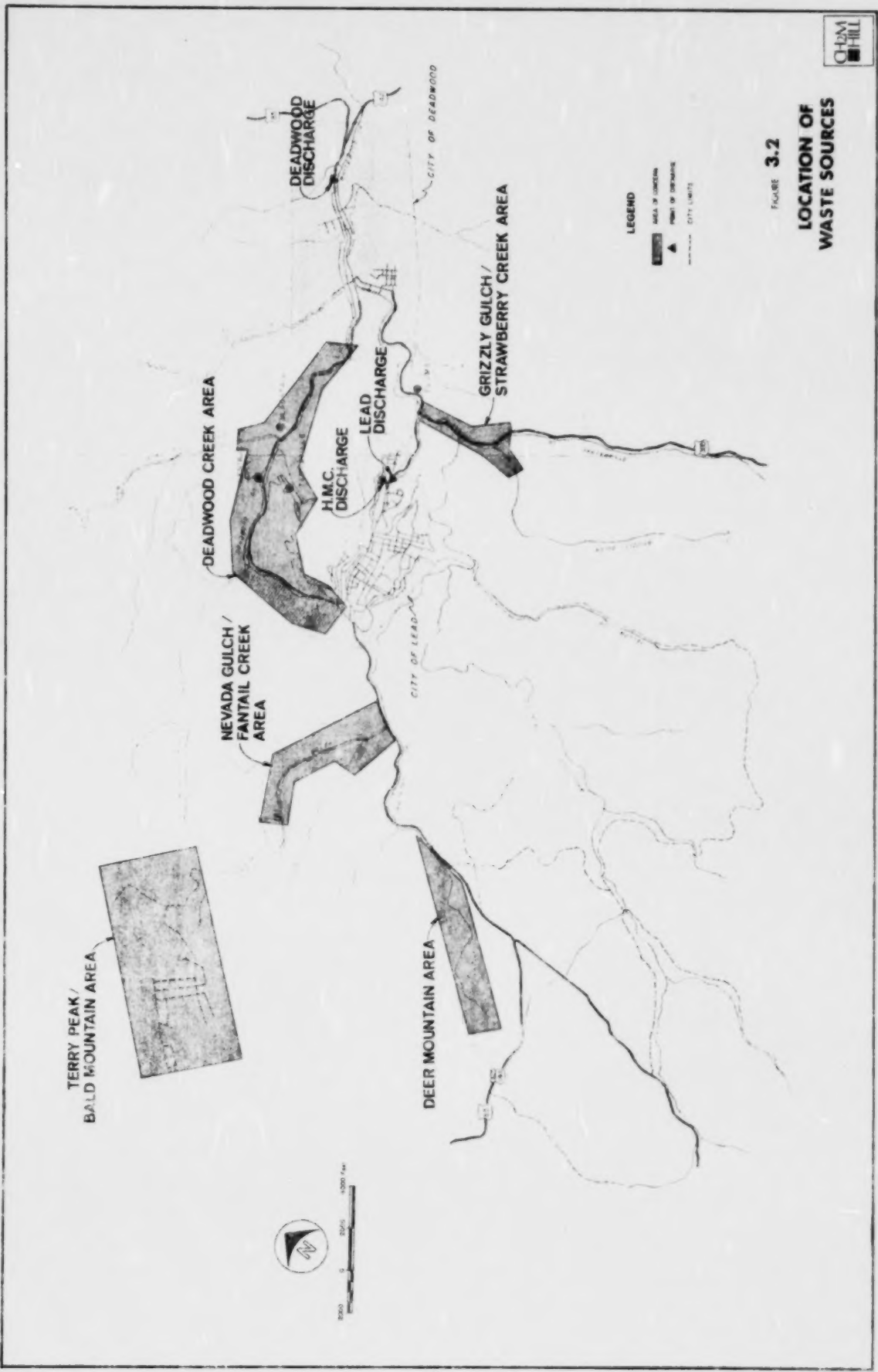
C Investigation of Gold Run Creek Outfall Water. Colorado School of Mines Research Institute, 1974. Grab sampled October 1973.

(2) Not detected.

Table 3.5 shows the water quality of the streams above the major industrial and municipal discharges. These waters are affected by septic tank and raw sewage discharges from the Golden Gate-Central City-Blacktail and Whitetail-Fantail-Nevada Gulch areas. In addition, old tailings and iron-rich porphyry formations subject to surface erosion can be found along the upper reaches of Deadwood, Whitetail, and Whitewood Creeks, which reportedly run "red" during the spring.

Table 3.6 shows the water quality data on Gold Run and Whitewood Creeks below the municipal and industrial discharges. As described earlier, HMC discharges sand and slime mill tailings, along with process water, into the lower end of the Lead collection system, which discharges into Gold Run Creek. While most of the slime portion of the tailings is discharged into Gold Run, a major portion of the sand is water-flooded back into the mines. From Gold Run the combined flows enter Whitewood Creek. Small sanitary sewers empty into Whitewood Creek as it flows through Pluma and Deadwood, with the majority of Deadwood's sewage discharged into the Creek near the northern end of the City.





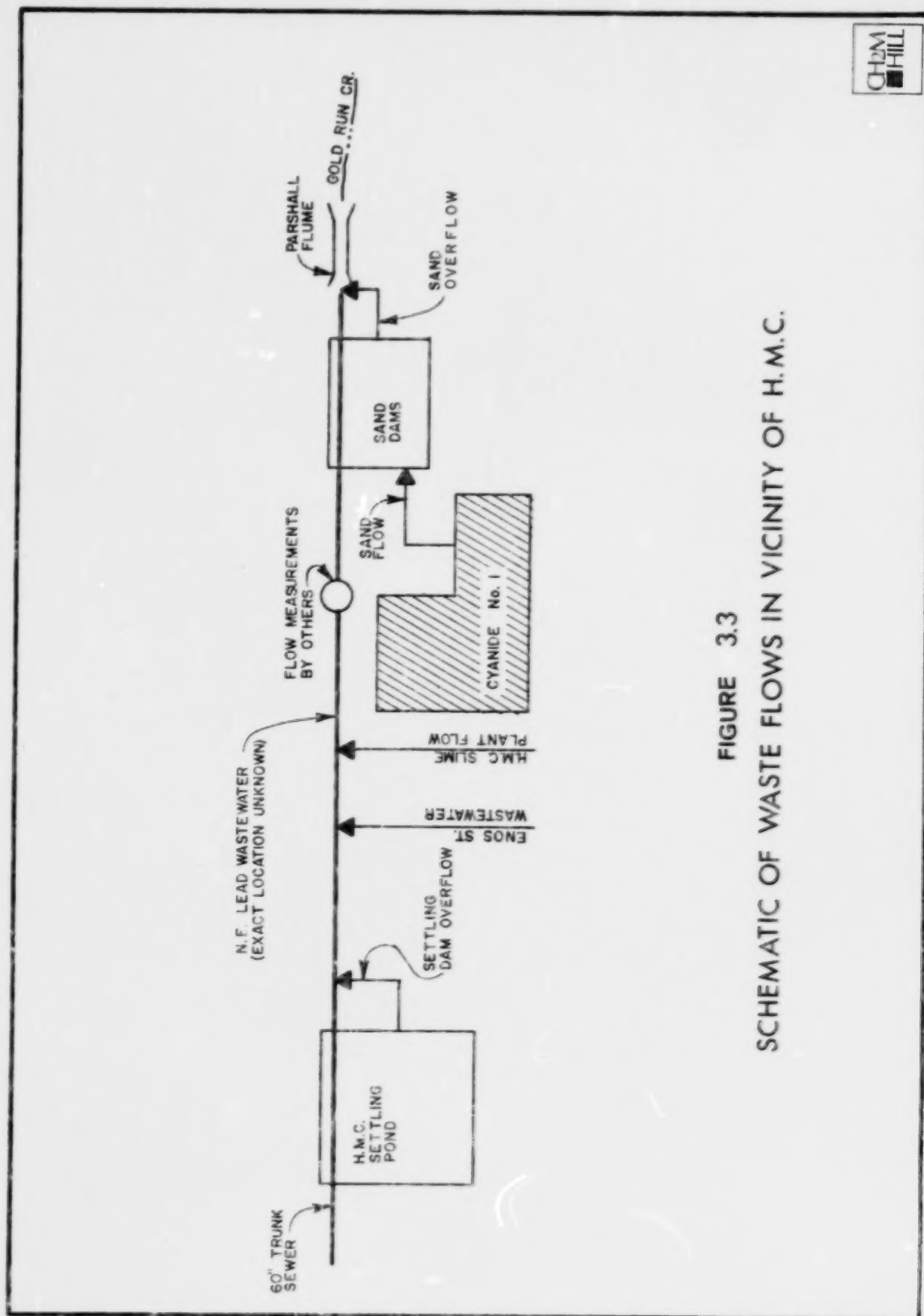


FIGURE 3.3
SCHEMATIC OF WASTE FLOWS IN VICINITY OF H.M.C.

Chapter 4 EXISTING WASTEWATER FACILITIES

The Cities of Lead and Deadwood have central wastewater collection systems but do not provide treatment of the collected flows before they are discharged. Small areas of Lead with separate collection systems have limited treatment of their wastewater through the use of septic or Imhoff tanks. For the most part, the outlying portions of the study area have no wastewater facilities.

LEAD

As discussed in Chapter 3, wastewater within the City of Lead is combined with storm water in a gravity flow collection system. The collection system also receives most of the industrial waste flow from HMC just prior to discharging into Gold Run Creek.

There are six separate areas of Lead with collection systems that are not part of Lead's main system. The North Washington Street collection system discharges untreated wastewater onto a hillside. The waste enters Gold Run Creek at the bottom of the hill between Lead and Pluma. The other five systems include facilities consisting of septic tanks or Imhoff tanks. The Glendale collection system discharges into Deadwood Creek, and the Canyon Street system discharges into Whitewood Creek. The remaining three systems are South Main, Pavilion Street and Matthew Street, which discharge into Whitetail Creek. The untreated domestic wastewater from HMC's Yates and Ross Shafts is also discharged onto a hillside, and the subsequent surface runoff flows into Whitewood Creek.

Most of the existing facilities were installed between 1900 and 1904, with replacement facilities and additional lines constructed as needed. The systems consist of wood stave, brick, concrete, clay and corrugated metal pipes 8 to 60 inches in diameter. Portions of the systems are perforated or were laid in an open-joint fashion to facilitate the collection of ground water. The records of construction are such that only the general location of the collection systems can be determined.

The condition of the systems is unknown because systematic inspections have not been conducted. Maintenance of the systems is complicated because of problems with root intrusion, methods of construction, and pipe materials used. In addition, tailings from the Wasp Mine are used for sanding the streets during the winter months. This causes additional

plugging within the sewer lines, although the degree of the plugging caused by using tailings (versus normal sanding materials) is unknown.

DEADWOOD

The City of Deadwood's separate wastewater and storm water collection systems were constructed in the 1890's. The wastewater collection system consists of 8- to 24-inch diameter pipes which are primarily clay and cast iron. The drawings on record for the major portion of the system were destroyed in a fire. Therefore, only the approximate location of the system is known. The existing collection system ends near the rodeo grounds, where the untreated wastewater from Deadwood is discharged into Whitewood Creek. There are an estimated 70 homes in Deadwood and the Cliff Street area that are not connected to the main collection system. These homes discharge untreated wastewater or septic tank effluent into Whitewood Creek at various locations.

The condition of the systems and maintenance problems are similar to those of the Lead system.

OUTLYING AREAS

Areas surrounding Lead and Deadwood consist primarily of scattered housing sites that have no central wastewater collection system. Only Central City has a central storm water collection system. Some of the homes in the outlying areas have septic tanks or cesspools, while others discharge untreated wastewater into nearby creeks. The septic tank effluent is disposed of by percolation into the soil or discharged into a creek.

Chapter 5 ALTERNATIVE DEVELOPMENT AND SCREENING

After the establishment of the objectives and evaluation criteria discussed in Chapter 1, the development of the Facilities Plan involves five phases. This five-phase development is shown on Figure 5.1 and described below. All five phases have been completed.

1. Definition of subsystem components. During this phase many components or subparts of a wastewater management system were defined and analyzed. Components that appeared impractical were eliminated from further consideration. Components common to numerous wastewater management systems were identified and analyzed to reduce the number of alternative systems to be developed. Through this process a set of component parts were clearly defined for combination into wastewater management alternatives.
2. Definition of alternative wastewater management systems. Numerous alternative wastewater management systems were defined during this second phase, using various combinations of the subsystem components developed in phase one.
3. Preliminary wastewater management systems evaluation. The objective of this phase was to reduce the number of alternative systems under consideration by a preliminary evaluation of system costs, capabilities, environmental impacts, and implementation arrangements. As a result of this analysis, three wastewater management alternatives were selected for an additional competitive evaluation.
4. Competitive evaluation of selected wastewater management systems. A detailed evaluation was made of the three wastewater management alternatives determined to be the most viable during the preliminary screening. The competitive evaluation reviewed and identified additional tradeoffs associated with implementing each alternative.

During this phase, the District decided that all of the alternatives being evaluated were unacceptable. As a result, a new alternative was defined. Another final comparative evaluation was then made between the new system and the system that was found to be the most viable in the previous evaluation.

5. Selection of a wastewater management system. The information developed during the comparative evaluations was presented by the District at public hearings to identify the wastewater management system to be ultimately implemented.

This chapter presents the study results of the first three Facilities Plan phases. Descriptions of the three wastewater management alternatives selected for competitive evaluation are given in Chapter 6. The competitive evaluation, phase four, is discussed in Chapter 7. Finally, in Chapter 8, the two systems compared in the final evaluation are identified, and the various public hearings and meetings are documented.

DEFINITION OF SUBSYSTEM COMPONENTS

The development of wastewater management alternatives for the District involved an evaluation of the six subsystem components shown on Figure 5.1 and listed below.

- Wastewater collection
- Wastewater treatment level
- Wastewater treatment systems
- Treatment sites
- Sludge disposal
- Flow reduction

A detailed evaluation of the subsystem components can be found in an appendix report entitled "Definition of Treatment Requirements and Alternatives, Task 11" by CH2M Hill for the Lead-Deadwood Sanitary District No. 1. The information presented below summarizes the significant findings of that report and identifies the subsystem components used to develop alternative wastewater management systems.

WASTEWATER COLLECTION

Effective management of the study area's wastewater must consider extension of the existing centralized collection systems into presently unsewered areas. Twenty-six areas outside the Lead and Deadwood central systems were identified for possible inclusion in an areawide collection system, as shown on Figure 5.2. Some or all of these sections could be connected into a central system, depending on the extent of coverage desired. The 26 sections were combined into the following major groups to simplify the development of costs for alternative wastewater management systems:

- Deadwood Creek System, as shown on Figure 5.2.
- West Outskirts, as shown on Figure 5.2.
- Pluma-Grizzly Gulch-Strawberry Creek Collection Systems.
- Deadwood System, including existing central system and unconnected areas within the City.
- Lead System, including existing central system, North Washington Street branch, and Gold Run interceptor.
- Lower Whitewood Interceptor and Deadwood Interceptor (included in City of Deadwood), required if Lead and West Outskirts flows are treated at a plant northeast of Deadwood.

Task 11 described the facilities and variations that would be required for each of these major groups as determined by the management alternative. Regardless of the alternative, the collection system developed for the Lead-Deadwood area would provide basically the same degree (or area) of coverage. Minor differences within each alternative are associated with the location of the treatment plant and the necessity of pump stations. The configuration of the collection system is depicted on diagrams defining the various alternatives presented later in this report.

WASTEWATER TREATMENT LEVEL

Early in the planning process the District expressed concern about the cost of implementing the high treatment level required to achieve the effluent limitations. Therefore, two lower levels of treatment were also analyzed in an effort to identify compromise solutions. A comparison of all three treatment levels helped define the relative economic and environmental impacts and cost-benefit ratio of implementing a high treatment level to meet the effluent limitations. The three treatment levels can be generally defined as follows:

- Level 1 treatment would satisfy the NPDES Discharge Permit and the South Dakota Surface Water Quality Standards for a permanent cold water fishery objective.
- Level 2 treatment would be secondary treatment plus effluent filtration and would satisfy neither the NPDES Discharge Permit issued to the District nor the State Surface Water Quality Standards.

- Level 3 treatment would be secondary treatment and also would satisfy neither the NPDES Discharge Permit nor the State standards.

The effluent characteristics for each of these treatment levels are given in Table 5.1. Adoption of either Level 2 or 3 required modification of the effluent limitations established under the cold water fishery objective. If a system producing Level 2 or 3 treatment were to be implemented, it must have the flexibility to be upgraded to a higher treatment level to achieve the zero discharge goal of 1985, as required by Public Law 92-500.

WASTEWATER TREATMENT SYSTEMS

Five wastewater treatment systems were analyzed:

- Advanced biological system
- Physical-chemical system
- Land-based treatment system
- Aerated lagoon system
- Stabilization pond system

All three treatment levels were analyzed for the biological and physical-chemical treatment systems. Only Level 1 treatment is associated with a land-based system, while the aerated lagoon system and stabilization ponds could provide only Level 3 treatment.

Because both separate and combined municipal/industrial treatment systems were considered, the requirements for treating HMC's wastes were examined independently. These requirements are discussed at the end of this section on treatment systems.

Of the above five systems, the advanced biological, aerated lagoon, and stabilization pond systems were analyzed for treating only the District's municipal wastes. The physical-chemical and land-based systems would treat both the District's and HMC's wastes.

Advanced Biological System

Figure 5.3 is a schematic diagram for a biological treatment system designed to handle domestic wastewater only. Pretreatment of the raw wastewater consists of screening to remove grit and large solid material.

Biological oxidation of the organic material would be accomplished in a fixed-film reactor followed by supplementary aeration for nitrification. The dilute nature of the domestic waste was described in Chapter 3. A fixed-film reactor would allow the development of the increased sludge concentration

Table 5.1

TREATMENT LEVEL EFFLUENT CHARACTERISTICS

Parameter (1)	Level 1 Required Effluent Limitations (2)	Level 2 Secondary Treatment Plus Filtration (3)	Level 3 Secondary Treatment (3)
BOD ₅			
Average	10	10	30
Maximum	17.5	17.5	45
Total Suspended Solids			
Average	10	10	30
Maximum	17.5	17.5	45
Fecal Coliform (MPN/100ml)			
30-day Average	200	200	200
7-day Average	400	400	400
Coliform (MPN/100ml)			
30-day Average	1000	1000	1000
7-day Average	2000	2000	2000
Dissolved Oxygen	7	6	--
Total Dissolved Solids	1500	1500	1500
Total Alkalinity (CaCO ₃)	750	--	--
Total Residual Chlorine	0.05 (0.02) (4)	0.05	1.0
Chlorides	100	--	--
Ammonia as N	1.0 (0.6)	--	--
NO ₃	50	--	--
pH Units	6.6 - 8.6	6.0 - 9.0	6.0 - 9.0
Turbidity (JTU)	10	50	50
Total Iron	0.3 (0.2)	--	--
Free Cyanide	0.005 (0.002)	--	--
Total Cyanide	0.03 (0.02)	--	--
Total Arsenic	0.16 (0.1)	--	--
Total Cadmium	0.005 (0.003)	--	--
Total Chromium	0.08 (0.05)	--	--
Total Copper	0.03 (0.02)	--	--
Total Lead	0.08 (0.05)	--	--
Dissolved Lead	0.022 (0.015)	--	--
Total Mercury	0.0003 (0.0002)	--	--
Total Nickel	0.31 (0.2)	--	--
Total Silver	0.0003 (0.0002)	--	--
Total Zinc	0.06 (0.04)	--	--
Oil and Grease	10.0	--	--
Undissociated Hydrogen Sulfide	0.003 (0.002)	--	--
Conductivity (micromhos/cm)	1500	--	--
Na Adsorption Ratio (Units)	10	--	--

(1) All units are mg/l except as noted.

(2) Discharge to Whitewood Creek at South Deadwood.

(3) Would not satisfy cold water fishery water quality objectives.

(4) Values in () are required for discharge into Whitewood Creek at Pluma.

and age necessary for the required biological oxidation. Nitrification (the oxidation of ammonia to nitrate) would occur in a small supplementary aeration basin between the fixed-film reactor and a final clarifier. Sludge would be returned from the final clarifier to the fixed-film reactor. Effluent from the fixed-film reactor would also be recycled to increase treatment efficiency.

Effluent from the secondary clarifier would flow through a flow equalization pond before going to a mixed media filtration process for additional suspended solids removal. Flow equalization is provided to equalize the hydraulic loading, thereby reducing unit size and increasing treatment efficiency. Filtration aids such as polymer or alum could be added to increase the filtration efficiency.

The biological fixed-film reactor and supplementary aeration basin would be designed to nitrify most of the ammonia present in the wastewater. However, additional ammonia oxidation would be necessary in order to achieve the desired effluent limitation of 0.6 mg/l. Breakpoint chlorination would be used to oxidize the remaining ammonia to nitrogen gas. The unit would be large enough to handle normal fluctuations in the nitrification efficiency of the biological treatment process. In order to prevent the formation of nitrogen trichloride, an odorous and potentially explosive gas, pH control of the breakpoint chlorination process would be necessary, along with adequate reaction chamber ventilation and thorough mixing.

A conventional chlorine disinfection system would be used to meet the bacterial standards. Dechlorination by addition of sulfur dioxide or some other dechlorinating agent would be necessary to meet the total residual chlorine standard of less than 0.05 mg/l. Effluent reaeration may be required to meet the dissolved oxygen requirement of 7 mg/l. If the wastewater temperature approaches 20° C during the spring and fall spawning season, achievement of the 7 mg/l effluent dissolved oxygen standard would be difficult.

Physical-Chemical System

Figure 5.4 presents a schematic diagram for a physical-chemical treatment system that could be utilized on combined industrial-domestic influents. Due to the extremely dilute nature of the expected combined industrial-domestic waste, a biological treatment system for combined wastes is considered impractical.

Grit and large solids would be removed by screening before the wastewater is discharged into a single-stage lime clarification system. This clarification process would be a rapid mixing system with a detention time of about 2 to 4 minutes. The wastewater would then be held in a flocculation chamber

for approximately 30 minutes, with moderate mixing to allow the suspended solids material to coagulate. The majority of the suspended solids material and a substantial portion of the heavy metals would then be removed in a chemical clarifier. Sludge from the clarifier would be thickened in a gravity thickener prior to sludge disposal. The pH of the chemical clarifier effluent could be adjusted either by the addition of carbon dioxide (recarbonation) or acid. Additional suspended solids removal would be accomplished in a mixed media filter. Included within the mixed media filtration process would be a flow equalization chamber to level out the hydraulic loading on all downstream processes. Constant hydraulic loading would result in smaller unit sizes and greater process efficiency, as noted earlier. Filter aids such as polymers would be added prior to filtration to improve suspended solids capture. The filter would be backwashed with wastewater effluent to transport the entrapped suspended solids material to a filter backwash treatment pond. Overflow from this pond would be returned to the headworks of the treatment processes, while the suspended solids would be allowed to settle. Periodic removal of accumulated suspended solid material would be required.

Ammonia would be removed by selective ion exchange. The ion exchange media would be a zeolite such as clinoptilolite, which is selective for ammonia relative to calcium, magnesium, and sodium. The ammonia capacity of clinoptilolite has been found to be nearly constant for a wide pH range of 4 to 8, but diminishes rapidly outside this range. Regeneration of the clinoptilolite can be accomplished with salts such as NaCl.

It should be noted that suspended solids carried over from the mixed media filters could cause serious plugging of the ion exchange media. Plugging could also be caused by failure of the lime clarification process. Pilot plant studies would be necessary to determine the severity and impact of these problems prior to actual design.

The key to the applicability of this process is the method of handling the spent regenerate. Following regeneration, the ammonia-laden spent regenerate volume is about 5 to 6% of the throughput treated prior to regeneration. The regenerate cannot be discharged into the aquatic environment without further treatment. A new ammonia removal and recovery process (ARRP) developed by Larry G. Kepple of CH2M Hill (patent pending) could be used to treat the regenerate and allow the recovery of ammonium salts. The process recovers ammonia in a form for use as a common fertilizer, which could be sold as a byproduct. This process is a modification of the ammonia stripping process and requires that the ammonia be in solution as a dissolved gas. The process is explained in greater detail in the Task 11 report.

The efficiency of the selected ion-exchange process for the removal of ammonia is approximately 95%. Additional ammonia oxidation would be required in order to meet the effluent limitation for ammonia of 0.6 mg/l. Breakpoint chlorination could be used to oxidize ammonia to nitrogen gas. As in the biological system, the pH would have to be controlled to prevent the formation of nitrogen trichloride.

Some soluble organics and certain heavy metals that might not be removed by upstream processes can be adsorbed on activated carbon. The carbon adsorption process would also remove the chlorine added for ammonia oxidation. Spent carbon would be regenerated in a small electric furnace to reduce operating costs and sludge disposal volumes.

This physical-chemical system would not produce as low a soluble effluent BOD₅ as a biological system. There is some doubt that this system could consistently meet the BOD₅ and suspended solids effluent limitations set forth in the NPDES Discharge Permit (Table 2.1). Prediction of actual performance would require extensive pilot plant studies prior to design.

Data developed from other advanced wastewater treatment systems have indicated the necessity of effluent disinfection to meet the bacterial standards. Effluent disinfection would be accomplished in a conventional chlorine disinfection system followed by dechlorination by sulfur dioxide or another dechlorinating agent. Effluent reaeration may be necessary to achieve the dissolved oxygen standard of 7 mg/l before the effluent can be discharged into the receiving stream.

Land-based Treatment System

The land-based treatment system proposed is similar to the Grizzly Gulch Treatment System (GGTS) developed in previous studies. A detailed evaluation of GGTS can be found in "Evaluation of the Grizzly Gulch Treatment System," Task 10 of the Facilities Planning procedure, by CH2M Hill.

The land application alternative consists of a wastewater storage reservoir, pump station, transmission pipeline, distribution system, sprinkler system, telemetry, and automatic control and monitoring, as shown on Figure 5.5. Two options for this alternative have been evaluated for tailings and wastewater storage. The wastewater would be stored in Grizzly Gulch for about 6 months during the winter period and would be applied during the summer. The sprinkler irrigation system would distribute the water uniformly over the irrigated area, located southwest of the Yellow Creek headwaters. Many pollutants would be removed by the vegetation and soil as the water moves through the soil and rock profile. The pollutant removal

mechanisms would include filtration, oxidation, crop uptake, adsorption, precipitation, denitrification, and ion exchange.

The applied water would infiltrate the soil and percolate slowly through the restrictive clay layer. The percolate would move vertically through the soil and fractured rock to the ground water. The quantity of water reaching the ground water reservoir would be 3 to 8 times the present (natural) quantity. The ground water would move laterally downslope, as occurs at the present time, and would reappear as surface flow in streams, ravines and gulches on and near the irrigation site. Thus, streamflows in the area would also be increased by an estimated 3 to 8 times present values.

Based on presently available data, natural drainage should be sufficient. Therefore, little or no drainage construction would be required. These assumptions have been made without surface or subsurface investigations of the proposed site. Field investigations would be required to verify the assumptions made for this analysis. An investigation of soil and geologic materials would be required to verify the technical feasibility of the proposed land-based system.

Aerated Lagoon System

The aerated lagoon treatment system would handle the domestic wastewater flows from the District only. The treatment facility would consist of two parallel systems, each with two aerated lagoons and one nonaerated lagoon in series capable of handling one-half the total wastewater flow. The system would be designed so that either series or parallel operation could be utilized. A schematic flow diagram of the lagoon treatment system is shown on Figure 5.6.

The four aerated lagoons would be completely mixed. Each of these lagoons would have a surface area of 1 acre and provide 2-day detention of the waste. Each of the nonaerated lagoons would have a 4-acre surface area and provide a 6-day detention period for the removal of suspended solids and additional treatment of any remaining soluble BOD₅. In the summer, algal blooms could cause effluent suspended solids levels above those specified in the NPDES Discharge Permit (Table 2.1).

Solids in these lagoons would be reduced by anaerobic processes, but periodic sludge removal and disposal would still be required. The lagoon effluent would be chlorinated before discharge.

Stabilization Pond System

A series of stabilization ponds could biologically treat the domestic waste from the District only. This method of treatment

was investigated because it generally has lower capital and operating costs than an aerated lagoon system. It does, however, require extensive land commitments and also has potential odor problems.

The stabilization ponds would involve both aerobic and anaerobic biological treatment. The raw wastewater would be introduced into the first pond, where the quiescent conditions would permit sedimentation of the solids. Upon settling to the bottom of the pond, the solids would be anaerobically decomposed. The more soluble organics would be broken down within the aerobic zone closer to the surface. Transferring the decant to subsequent basins would permit more complete oxidation of the wastes.

Figure 5.7 is a schematic of the stabilization pond configuration. The total pond surface area would be approximately 140 acres and total detention time would be 180 days. The dikes would be 10 feet high with side slopes of 3 horizontal to 1 vertical. It would be necessary to seal the pond bottoms and slopes to prevent leakage and possible ground water contamination. In addition, slope protection from wave action would be required. All exposed surfaces would have grass cover except the top of the dikes, which would be gravel service roads. A fence would surround the site.

The influent would be measured by a Parshall Flume and then would enter an inlet box. The wastewater would then be delivered to either or both of the first ponds. Transfer between the ponds would permit either parallel or series operation of the ponds, providing greater flexibility. The depth of the wastewater would be controlled by slide gates within the transfer and outlet structures.

This ability to vary the depth of the wastewater permits more efficient operation. During the summer, when biological activity is high, the ponds could be operated near full depth. In the fall, the wastewater level would be lowered to permit storage of the wastewater during the winter months, when biological activity is reduced.

In the summer, algal blooms would increase suspended solids levels in the system beyond those specified in the NPDES Discharge Permit (Table 2.1). However, the relatively long detention time gives this system the ability to discharge at selected times of the year, minimizing the impact on the stream.

Although the biological oxygen demand of the effluent is expected to be low, chlorination would be provided to ensure the ability to meet the bacterial standards.

HMC Waste Treatment

A review of the present treatment technology for handling waste similar to that produced at HMC is presented in Task 13.1, entitled "Technology Review for Treatment of Homestake Mining Company Wastewater." That report contains descriptions of several treatment processes which have been considered for use on the HMC wastewater. The study concluded that a major effort should be made to develop a satisfactory method for cyanide recycle within the slime plant.

Several processes have been identified as candidates for the treatment of HMC's wastewater. These processes include air stripping of cyanide, alkaline chlorination for the oxidation of cyanide, ozonation for the oxidation of cyanide, chemical precipitation, and activated carbon adsorption.

An integral part of the wastewater control program for HMC is the development of an effective recycle program. Until the nature of the recycle program has been completely defined and the characteristics of the wastes can be estimated, further development of candidate treatment processes would not be productive. To allow an economic comparison of separate versus combined industrial-municipal treatment systems, the treatment system shown on Figure 5.8 has been assumed for use by HMC.

The treatment process shown on Figure 5.8 involves alkaline chlorination for the oxidation of cyanide to carbon dioxide, nitrogen, and water. The treatment process includes the addition of lime in a flash mix tank to raise the pH. The oxidation of cyanide would occur in a two-chamber unit, with the formation of cyanogen chloride and the hydrolysis of cyanogen chloride to cyanate occurring in the first chamber and the oxidation of cyanate to nitrogen and carbon dioxide occurring in the second chamber.

The pH of the wastewater during the cyanide oxidation process is very near the optimum pH for precipitation of heavy metals. Any precipitated solids and additional suspended solid material would be removed in a chemical clarifier with an integral flocculation chamber. Part of this solid material would be returned to enhance flocculation and sedimentation. Waste sludge from this process would be combined with the filter backwash and transported to the tailings pond for disposal. Effluent from the flocculator-clarifier would discharge to mixed media filtration for the removal of additional suspended solid material. The effluent from this process could then be discharged to the stream or recycled to the mill for reuse.

The exact effluent quality expected from this system cannot be estimated until the nature of the waste from the HMC recycle program is known and pilot plant information regarding treatment capabilities has been collected.

If its quality permits, the effluent would be discharged into Whitewood Creek. Therefore, some form of dechlorination may be required. The amount of dechlorination can only be determined with actual operating experience or pilot plant testing.

HMC Pretreatment System

Combined municipal and industrial wastewater treatment can be provided in the physical-chemical treatment system previously outlined. It is assumed that HMC would provide pretreatment of their wastes, utilizing cyanide oxidation by alkaline chlorination, immediately prior to discharge into the combined municipal-industrial treatment system. Because the pH required for the alkaline chlorination process is at or near optimum for heavy metal precipitation, long pipeline routes between the pretreatment and combined municipal-industrial treatment plant would create pipe scaling problems. Therefore, the pretreatment system must be located immediately adjacent to the combined municipal-industrial system. However, transport of HMC's cyanide wastes to the pretreatment site could create a hazard if routed through residential areas because a change in the pH of the water could cause the release of gaseous cyanide. This possibility should be thoroughly investigated.

Other pretreatment alternatives should be investigated by HMC once the exact nature of the recycle system is known and the expected wastewater characteristics can be simulated. Other processes, such as air oxidation, ozone oxidation, chemical precipitation and activated carbon adsorption, should be analyzed and tested in an effort to define the most cost-effective pretreatment system.

TREATMENT SITES

Five general treatment plant locations were defined for analysis. Not all of the sites are compatible for each of the treatment systems examined. The sites considered appropriate for each of the different systems are indicated on Figure 5.1. The five sites are described below.

- Lower Deadwood, near the rodeo grounds. A treatment plant could be located in the City of Deadwood, immediately north of the rodeo grounds parking lot, near the confluence of Whitewood Creek and Spruce Gulch. This site is presently the location of an auto wrecking yard immediately south of the old slag pile.

- Grizzly Gulch. A major treatment plant could be located adjacent to the existing HMC airshaft in Grizzly Gulch. Grizzly Gulch is also the assumed site for a tailings dam to be built and maintained by HMC.
- Lead site. A small treatment plant could be located in the vacant draw immediately east of Blackstone Drive and south of Main Street. This area presently contains an exposed section of the wood stave wastewater collection interceptor.
- Lower Whitewood Creek Valley. The nearest potential site for the construction of stabilization ponds is located approximately 3 miles downstream from the City of Whitewood, along Whitewood Creek.
- Slaughterhouse Gulch. A small aerated lagoon system could be constructed in Slaughterhouse Gulch, which intersects Whitewood Creek approximately 2 miles north of the Deadwood city limits. The lagoon site would be a large grassy meadow visible from Highway 14, approximately 1 mile north of Deadwood.

SLUDGE DISPOSAL

Sludge disposal is assumed to be in the proposed HMC Grizzly Gulch tailings pond. Sludge could be trucked or pumped to the impoundment. Preliminary cost estimates appear to favor trucking of liquid sludge to the disposal site. However, the best method of transport will be studied further upon final selection of treatment plant sites.

Stabilization of the biological sludge prior to disposal would be necessary. Because the treatment plants would be small, aerobic digestion was chosen as the stabilization method. It would not be necessary to stabilize the lime sludge produced in the physical-chemical treatment system.

The sludge produced in the clarifiers would have a solids content of approximately 1%. To reduce the volume of material that would be transported for disposal, thickeners would be used. Thickeners can be expected to thicken the sludge to approximately 4% in the biological plants. This thickening step would result in a four-fold decrease in the volume of sludge from the biological plants. Thickeners used in the physical-chemical plants would thicken sludge to approximately 8% solids, resulting in an eight-fold decrease in volume.

The effect (on the tailings deposits) of disposing of sludge in the tailings pond is not fully known. Adverse effects to the tailings deposits are not expected because the amount of domestic sludge is minute in comparison to the daily volume of tailings. Nevertheless, further investigations are required.

Sludge treatment and disposal systems would not be required for the land-based treatment system because any biological sludge generated in the holding pond would be mixed with the tailings and remain in the tailings pond. Suspended solids material from the tailings pond effluent would be incorporated into the soils layer at the land-based treatment application site.

No special sludge disposal equipment would be required for the waste stabilization pond and aerated lagoon systems. The sludge that would accumulate in these ponds or lagoons could be periodically removed for disposal. The sludge from the stabilization ponds could be disposed of in the tailings pond in Grizzly Gulch or spread on agricultural land in the Whitewood Creek Valley. Sludge from the lagoon system would be disposed of in the tailings pond.

FLOW REDUCTION

Excessive infiltration/inflow is defined as the quantity of flow that is more economical to eliminate (through rehabilitation of the sewer system) than to transport and treat in a sewage treatment plant. The definition of excessive infiltration/inflow is more applicable to separated sewer systems than it is to combined sewer systems because the combined systems are designed to handle inflow. However, if the infiltration/inflow must be treated, its control in the combined system becomes important.

Lead

The City of Lead has a combined sewer system with no wastewater treatment. Raw domestic wastewater, infiltration, and inflow are discharged directly into local streams. The question of whether infiltration/inflow is excessive can only be addressed after overall wastewater management alternatives have been defined and a limited number of candidate systems determined.

To meet State and Federal wastewater discharge standards, the total Lead flow (including infiltration and inflow) must be treated or the combined sewer system must be separated. The cost-effective solution to the overall wastewater problem in the Lead-Deadwood area can be determined by a comparison of project costs for the collection, flow reduction, treatment, and sludge handling alternatives of each of the wastewater management systems.

Description of Flow Reduction Alternatives. The flow reduction alternatives must deal primarily with the problem of excessive storm water flows (inflow) in Lead's combined sewer system. Infiltration and domestic sewage flows in Lead are insignificant when compared to the relatively massive storm water flows which are possible in this sewer system.

Infiltration/inflow correction must involve either (1) sewer separation with diversion of essentially all storm water flow, untreated, to Gold Run Creek or (2) containment of all flow from the combined sewers (inflow, infiltration and domestic sewage) in a holding pond. In the latter case, the entire volume of the holding pond would require treatment but could be processed through the treatment facilities at a controlled rate.

Five alternatives were considered for Lead as part of the flow reduction subsystem analysis:

- Alternative A - Sewer separation by construction of a new sanitary trunk sewer and new storm water branch and lateral sewers. The new lateral and branch storm water sewers would be connected to the existing sewer trunk. The existing lateral and branch sewers would be connected to the new sanitary trunk sewer and would serve as a sanitary sewer system.
- Alternative B - Containment of all flow from the existing combined sewer system, with treatment at a controlled rate.
- Alternative C - Sewer separation by construction of a new storm sewer system.
- Alternative D - Sewer separation by construction of a new sanitary sewer system.
- Alternative E - Construction of a bypass structure to discharge to Gold Run all storm flows over a predetermined value. The existing combined sewer system would remain in its present condition.

The first four flow reduction alternatives are depicted on Figures 5.9, 5.10, 5.11, and 5.12. Alternative E would not involve any major changes in Lead's present collection system. All five alternatives include provisions for the installation of new storm water catch basins, on an optional basis, to remove storm water from specific problem areas within Lead.

Flow Reduction Estimates. Alternatives A, C and D are designed to reduce inflow to negligible levels by disconnecting all direct catch basins, roof drains and foundation drains from a separated sanitary sewer system. The actual reduction of inflow would only be known after a sewer separation project is completed. However, it is reasonable to assume, based on experience, that inflow for Alternatives A, C and D would be zero.

Since Alternative B (storage and treatment of all flow) and Alternative E (bypassing excess storm flow) propose no significant changes in Lead's existing combined sewer system, infiltration and inflow would remain unaltered. Inflow in Alternative B would be directly proportional to the magnitude of storm events and could result in a significant increase in the quantity of flow to be treated. The holding pond included in Alternative B also creates an additional solids removal and disposal problem. Inflow in Alternative E would be limited to a predetermined value.

Infiltration flow reductions are expected for both Alternative A and Alternative D. No decrease in infiltration is expected for Alternative C (new storm sewer construction) because the existing Lead sewer system, with its present infiltration problems, would be used as the sanitary sewer system in this alternative.

Alternative A is expected to reduce infiltration by about 0.42 mgd, approximately 40% of the present 1.02 mgd dry weather infiltration. Most of this infiltration reduction would be achieved because the proposed new sanitary trunk sewer would avoid the present spring water infiltration problems along Julius Street.

Alternative D would result in the largest decrease in infiltration, about 0.74 mgd. This represents a 75% reduction in infiltration when compared to the estimated 1.02 mgd dry weather infiltration. The infiltration flow expected to remain in the new sanitary sewer system would enter the system through those portions of the existing sanitary sewer piping which would be connected to the new system.

Table 5.2 is a summary of infiltration flow reduction estimates for the five alternatives considered in the flow reduction analysis.

Alternative E would not significantly reduce the amount of inflow discharge to the stream. The bypass structure could be designed to bypass to Cold Run any flow over 4.9 mgd, which is the peak municipal waste flow from Lead.

Table 5.2

INFILTRATION FLOW REDUCTION ESTIMATES
CITY OF LEAD

Flow Reduction Alternative	Estimated Infiltration Flow Reduction (mgd)	Infiltration Flow Reduction (1) (percent)	Estimated Infiltration Remaining (2) (mgd)
A	0.42	41	0.60
B	None	0	1.02
C	None	0	1.02
D	0.74	72	0.28
E	None	0	1.02

(1) Based on a dry weather infiltration flow of 1.02 mgd.

(2) After construction.

Costs of Flow Reduction Alternatives. Detailed construction and operation and maintenance costs for the five flow reduction alternatives are summarized in Table 5.3. The costs for Alternatives A, B, C and E are based on a 10-year, 24-hour storm event. Costs for Alternative D apply to any storm event because this alternative would not involve a new storm water collection system.

Alternative A is the least expensive flow reduction alternative. This alternative would cost an estimated \$1.88 million and should reduce dry weather infiltration flow by approximately 40%.

Alternative B has the highest present worth. Alternatives B and E are the only flow reduction schemes which would not involve some form of sewer separation and still provide for treatment of all or part of Lead's storm flow.

Alternative B was not considered in subsequent project cost analyses. It has a high cost and does not reduce the amount of inflow and infiltration present in the existing system. It would also increase the amount of flow to be treated because most of the storm flow would be collected. In addition, the storm water holding pond would create a solids removal and disposal problem. Storm flow could not be treated in a biological treatment system because of the combined flows' large volume and low organic content. Physical-chemical and land-

Table 5.3

COST SUMMARY FOR FLOW REDUCTION ALTERNATIVES
(10-year storm)

Item	Alternative				
	A	B	C	D	E
<u>Sewer Piping</u>					
Storm Sewers					
Trunk Sewers	\$ -	\$ -	\$1,114,200	\$ -	\$ -
Branch and Lateral Sewers	641,900	-	641,900	-	-
Sanitary Sewers					
Trunk Sewer	429,100	-	-	429,100	-
Branch and Lateral Sewers	-	-	-	1,243,600	-
<u>Manholes</u>					
Storm Sewer Manholes	104,100	-	118,000	-	-
Sanitary Sewer Manholes	84,600	-	-	371,200	-
<u>Storm Water Diversion and Storage</u>					
Diversion - Headworks, Pipeline & Drop Chute	-	967,000	-	-	25,000
Access Road	-	382,000	-	-	-
Dam - Embankment and Reservoir Site Preparation	-	1,300,000	-	-	-
Reservoir Outlet	-	54,000	-	-	-
Emergency Spillway	-	115,000	-	-	-
<u>Miscellaneous</u>					
Existing Catch Basin Reconnections	40,800	-	40,800	-	-
Roof Drain Disconnections	26,400	-	26,400	5,000	-
Storm Sewer Outlet Structure	-	-	6,600	-	-
House Service Sewer Connections	95,000	-	-	792,000	-
Sewer Plugging, Supports & Pipe Connections	12,300	-	-	9,600	-
<u>Optional Storm Water Collection Facilities</u>					
New Storm Water Catch Basins	85,000	83,700	85,000	83,700	83,700
Associated Storm Sewer Piping	315,000	-	315,000	-	-
Associated Storm Sewer Manholes	42,000	-	42,000	-	-
TOTAL CONSTRUCTION COST	\$1,876,200	\$2,901,700	\$2,389,900	\$2,934,200	\$ 108,700
Operation & Maintenance (\$/year)	18,800	37,000	23,900	29,300	5,000
Total Annual Cost ⁽¹⁾	\$69,000	\$114,700	\$87,900	\$107,900	\$7,900
Total Monthly Cost ⁽¹⁾	\$2.30	\$3.82	\$2.93	\$3.60	\$0.26
Present Worth ⁽²⁾	\$2,055,000	\$3,255,000	\$2,617,000	\$3,213,000	\$157,000

(1) Based on 80% State and Federal grant with local cost amortized over 20 years with a 7% interest rate.

(2) Based on a 7% interest rate amortized over 20 years. Project cost distributed as follows: 20% first year, 48% second year, 32% third year, and O&M cost beginning in the third year. State and Federal grants have not been included.

based application treatment systems could handle the storm flow but would require a large treatment system and increased operation and maintenance costs.

Alternative C was also eliminated from subsequent project cost analyses. It has a considerably higher cost than Alternative A and, unlike Alternative A, does not offer any flow reduction advantages.

The cost estimates for the flow reduction alternatives are founded on a number of assumptions which must be verified in predesign work. Reasonable costs for rock excavation are included in the piping estimates. However, no costs for unusual rock blasting or removal problems are included. Costs for encountering unusual utility problems were also not included, and relatively broad assumptions were made concerning the number of roof drains and house service sewers which would require disconnection.

Deadwood

Like Lead, Deadwood has no wastewater treatment plant; the City discharges untreated domestic sewage into Whitewood Creek. Storm water flows in Deadwood are collected in a separate sewer system.

Inflow Sources. Basement sump pumps have recently been defined as a possible major source of inflow into the Deadwood sewer system. Inflow from this source is now being investigated. It is postulated that the total quantity of water from sump pumps entering the sewer system may be as high as 0.18 to 0.215 mgd during the dry weather season. These possible inflow figures represent 67 to 80% of the 0.27 mgd dry weather infiltration/inflow.

Basement sump pumps are presently thought to be few in number, on the order of 10 or 12. The quantity and quality of water contributed to the sewer system by these pumps during the wet season is unknown but should be determined.

Infiltration/Inflow Control. Infiltration/inflow control alternatives for Deadwood include such renovation techniques as sewer sealing to remove infiltration, removal of inflow sources such as sump pump discharges, and total treatment of all wastewater.

Sewer sealing to remove infiltration does not appear to be economically feasible. If inflow from basement sump pumps comprises 67 to 80% of the total dry weather infiltration/inflow in Deadwood, then the dry weather infiltration would amount to about 0.055 to 0.09 mgd. This flow is minor when

compared to total project wastewater flows of between 1 and 5 mgd for the various alternative treatment systems under consideration. The costs for locating (Sewer System Evaluation Survey) and removing (sewer system renovation) these small quantities of infiltration cannot be justified.

Instead, the flows discharged by the Deadwood sump pumps should be verified and costs determined for removal of these discharges from the sanitary sewer system. Removal of inflow from this source would entail discharge of the pump flow into the storm sewer system or directly into local streams.

Infiltration/Inflow Conclusions

Lead. Conclusions about whether or not infiltration/inflow is excessive in Lead will vary with each wastewater management system alternative. The conclusion in this report must be based on the assumption that future inflow (after construction) would be zero for the sewer separation alternatives and that the future remaining infiltration in the separated sanitary sewer system (without sewer system renovation) would be as estimated in Table 5.2. Excessive or nonexcessive infiltration/inflow can then be determined by comparing the estimated sewer renovation costs (to remove portions of the remaining infiltration) with the cost of treating the flow.

Flow reduction Alternative A would require an analysis of infiltration/inflow. The infiltration remaining in the sewer system after construction of Alternative A has been estimated to be 0.6 mgd. Renovation of the sewer system to remove all or part of this remaining infiltration could prove to be less expensive than treating it.

An analysis of infiltration/inflow would not be necessary for flow reduction Alternatives B, C, D and E. Alternative B, which would store and treat all flows in Lead, would preclude sewer system renovation. Alternative C is no longer a viable option as a wastewater management system because the costs for this alternative would be significantly higher than those for Alternative A, without any advantages of flow reduction. Alternative D would be, in essence, a new sanitary sewer system and therefore would not require an infiltration/inflow analysis. Alternative E would preclude sewer system renovation.

In summary, the cost of reducing infiltration/inflow depends on the flow reduction alternative. The cost of treating it is a function of the wastewater management alternative under consideration. During the preliminary systems evaluation phase, flow reduction Alternative E was selected for use with the final wastewater management alternatives. It was selected on the basis of its relatively low cost, ease of implementation,

and future flexibility. Because it provides for the treatment of most of the infiltration but very little of the inflow, this selection implies that infiltration in Lead is nonexcessive and inflow is excessive.

Deadwood. Immediate action should be taken to verify the basement sump pump flows in Deadwood and to determine the cost of redirecting these flows to the storm sewer system or a nearby stream. Considering the estimated inflow contribution of these sump pumps, the cost of removing the pump discharges from Deadwood's sewer system would probably be significantly lower than the cost of treating them.

Excessive or nonexcessive infiltration/inflow for Deadwood cannot be determined until wet weather flows are verified.

Flow Reduction by Homestake Mining Company

Homestake Mining Company is presently developing an in-mill water recycle system. As part of the water recycle development program, an extensive effort has been made to define the existing water system. With the completion of this task, it is possible to define candidate water recycle systems. The amount of flow reduction which can be achieved will not be known until the recycle program is implemented. Preliminary results indicate HMC's flow can be reduced to 0.8 mgd. To accomplish this flow reduction, a tailings pond water recycle system will be necessary. If domestic and/or storm flow from Lead is introduced into the tailings pond, the tailings recycle loop will not be practical, resulting in a net discharge of 1.6 mgd. Storm water entering the tailings pond would add to any flow leaving the tailings pond. The addition of the storm flow would result in a 1.0 mgd discharge from HMC with a tailings recycle loop. Special design precautions should be investigated to reduce the amount of storm flow entering the tailings pond.

HMC's waste discharge has been assumed to be the effluent from the tailings pond. The wastewater management systems developed below have assumed the point of discharge to be in Grizzly Gulch, below the proposed tailings dam. A preliminary review of the candidate HMC in-mill recycle system has indicated two possible points of wastewater discharge. In a combined domestic-industrial treatment system, the point of wastewater discharge would remain in Grizzly Gulch. Conversely, two points of wastewater discharge are possible with separate domestic-industrial treatment: the settling dam in Lead on Gold Run and the tailings pond in Grizzly Gulch.

DEFINITION OF ALTERNATIVE WASTEWATER MANAGEMENT SYSTEMS

DEFINITION OF BASIC SYSTEMS

By combining the various collection, treatment, treatment site, and sludge disposal subsystem components, five basic wastewater management systems were defined. These systems are described below. Once the basic alternative systems were developed, the appropriate flow reduction and treatment level subsystems could be determined for each system, as explained at the end of this section.

Wastewater Management System I

System I, shown on Figure 5.13, would have two treatment plants. One plant, located in Lead, would treat the waste from HMC, utilizing the processes outlined on Figure 5.8. Effluent from this process could be either discharged into Whitewood Creek (which would require the addition of dechlorination facilities) or utilized as a water source within HMC. HMC tailings and sludges would be transported to Grizzly Gulch, with excess water either carried back to the mill through a recycle system for further use as sluice water or treated and discharged. All of these treatment systems and equipment would be built and maintained by HMC.

A second plant, located in lower Deadwood near the rodeo grounds, would treat all of the domestic waste in the Lead-Deadwood area. This treatment plant would utilize a biological treatment process (outlined on Figure 5.3) prior to discharging into Whitewood Creek below Deadwood.

The collection system for the District would primarily be a gravity system that would transport the waste from the various outlying areas to the treatment plant site located below Deadwood. Three flow reduction alternatives (Alternatives A, D and E) were investigated in connection with System I to determine the most cost-effective solution.

Sludge generated in the treatment process would be trucked to the HMC tailings pond for disposal.

Wastewater Management System II

This system would have a combined industrial and municipal treatment plant located in Grizzly Gulch, as shown on Figure 5.14. The treatment schematic would be similar to the physical-chemical treatment plant shown on Figure 5.4. Effluent from the treatment facility would discharge into either Grizzly Gulch Creek or Whitewood Creek.

Pretreatment would be provided by HMC, using alkaline chlorination for the oxidation of cyanide, immediately prior to discharge to the jointly owned and operated treatment system. The pretreatment facilities would be located immediately adjacent to the joint treatment facilities.

Domestic wastes would be collected in a gravity system and discharged to a series of pump stations, as shown on Figure 5.14. The pump station in lower Deadwood near the rodeo grounds would lift the wastes from the City of Deadwood and the Deadwood Creek system to a pump station in the Pluma vicinity. The Pluma pump station would lift the wastes from the Deadwood pump station, along with the waste generated in the City of Lead and the outlying areas, to the treatment facilities located in Grizzly Gulch.

Sludge generated in the treatment process would be pumped and combined with tailings for disposal in the HMC tailings pond.

Wastewater Management System III

Under this system, a land-based system located in the Grizzly Gulch vicinity would be used to treat the combined industrial-municipal flows. The collection system for transporting the flows to Grizzly Gulch, as shown on Figure 5.15, would be identical to that for Wastewater Management System II.

Domestic wastewater from the District would be pumped to a combined tailings pond and winter storage lagoon located in Grizzly Gulch. Industrial wastes, including tailings from HMC, would be pumped in separate lines from the mill in Lead to the tailings pond in Grizzly Gulch. The dam constructed to contain the tailings would be large enough to provide winter storage for both the District's and HMC's wastewater.

Water decanted from the impoundment would be pumped and applied to forest land lying between the Whitewood and Yellow Creeks drainages. Effluent from the land application site would be allowed to percolate through the soil and collect in the natural streams.

Sludge disposal for the land-based treatment system would not be necessary, because any solids generated in the treatment of the waste in the lagoon would accumulate with the tailings deposits.

Wastewater Management System IV

A gravity collection system, similar to that in Wastewater Management System I, would collect the domestic waste from the District and transport it to a waste stabilization pond system

located 3 miles downstream of the City of Whitewood. The interceptor between Deadwood and the treatment site would follow the old railroad grade along Whitewood Creek to a point approximately 1/4 mile north of the old railroad tunnel. At this point the interceptor would leave the old railroad grade, traverse across a small valley, and proceed through a 3,000-foot tunnel into Centennial Valley. The wastewater would flow by gravity from this point through the City of Whitewood to the stabilization ponds.

Domestic treatment would be accomplished in waste stabilization ponds, as shown on Figure 5.16. The ponds would have a detention time of 90 days and a total surface area of 140 acres.

HMC would provide treatment in the same manner as in Wastewater Management System I, utilizing the processes outlined on Figure 5.8. This treatment plant could be located in Lead or Grizzly Gulch, and the effluent could be discharged into Whitewood Creek or utilized as a water source within HMC. As in System I, HMC tailings and sludges would be transported to Grizzly Gulch, and excess water would either be recycled for use as sluice water or treated and discharged. All of these treatment systems would be built and maintained by HMC.

Sludge disposal from the system would not be required, although periodic cleaning of the lagoon may be necessary within the design period. The accumulated sludge in the lagoon could be disposed of in the tailings pond in Grizzly Gulch or applied to agricultural lands adjacent to the treatment plant site.

Wastewater Management System V

A wastewater collection system, similar to that of Wastewater Management System I, would transport the domestic waste from the District to a pump station in Whitewood Creek Canyon at the confluence of Slaughterhouse Gulch. The domestic wastewater would be pumped from this point to an aerated lagoon system for treatment. The aerated lagoon system, shown on Figure 5.17, would provide essentially secondary level treatment prior to discharge into Slaughterhouse Gulch. Conditions for additional treatment through natural processes could be provided by constructing small pools, rock dams, etc., in the approximately 1/2-mile run of Slaughterhouse Gulch from the effluent discharge point to Whitewood Creek.

HMC would provide their own treatment in a system similar to that described for Wastewater Management Systems I and IV.

Special treatment facilities for the processing and disposal of waste sludge would not be necessary. Solids that accumulate within the lagoon systems must be periodically removed

and disposed of in the tailings pond located in Grizzly Gulch. It is anticipated that the solids would require removal once every 5 to 10 years. Sludge disposal could be accomplished by incorporating the waste sludge from the lagoons into the HMC tailings pond located in Grizzly Gulch.

DEVELOPMENT OF ALTERNATIVES

Each of the five basic systems was analyzed for several flow reduction alternatives, as shown on Figure 5.1. In turn, each of these alternatives was analyzed for several levels of treatment where appropriate. As a result of this procedure, 24 wastewater management alternatives were defined for analysis. They are shown on Figure 5.1.

The 24 wastewater management alternatives were coded by a numbering system that identifies the basic treatment system, the flow reduction option under consideration, and the designed level of treatment. The roman numeral (the first character in the numbering system) defines the basic wastewater management system. Following the roman numeral is a letter A, D or E that defines the flow reduction option in Lead under consideration. The last character, which is in parentheses, defines the level of treatment. For example, Alternative II-D(2) is a variation of the second wastewater management system (defined above) that would include a new sanitary sewer system in the City of Lead and provide Level 2 treatment (defined earlier in this chapter).

PRELIMINARY SYSTEMS EVALUATION

The 24 identified alternatives were given a preliminary screening, primarily on the basis of legal considerations and cost estimates. The costs developed for each of the alternatives are summarized in Tables 5.4, 5.5, and 5.6. Table 5.4 gives the annual cost for the District and HMC, as well as the total. The numbers in parentheses in this table are estimates of the monthly cost to each homeowner in the District. Table 5.5 presents the present worth analysis for each alternative, for both the District and HMC. Project costs and grant requirements for the alternatives are given in Table 5.6. Detailed breakdowns of the costs for each of the alternatives can be found in the appendix to the Task 11 report.

The screening or elimination procedure, as described in the following paragraphs, can be followed on Figure 5.1. During the screening, the most feasible lower treatment level system was identified for inclusion in a competitive evaluation to indicate the relative economic and environmental effects of the selected Level 1 treatment alternatives.

Table S.4
ANNUAL COST SUMMARY FOR WASTEWATER
MANAGEMENT ALTERNATIVES
(in dollars)

<u>System</u>	<u>LDSD #1</u>	<u>HMC</u>	<u>Total</u>
I-A Level 1	536,400 (17.88)	1,577,000	2,113,400
I-D Level 1	520,500 (17.35)	1,577,000	2,097,500
I-E Level 1	520,800 (17.36)	1,577,000	2,097,800
I-A Level 2	450,000 (15.00)	1,450,000	1,900,000
I-D Level 2	460,900 (15.36)	1,450,000	1,910,900
I-E Level 2	434,600 (14.49)	1,450,000	1,884,600
I-A Level 3	344,300 (11.48)	1,450,000	1,794,300
I-D Level 3	367,500 (12.25)	1,450,000	1,817,500
I-E Level 3	303,400 (10.11)	1,450,000	1,753,400
II-A Level 1	699,000 (23.30)	1,695,000	2,394,000
II-D Level 1	654,900 (21.83)	1,723,900	2,378,800
II-E Level 1	720,700 (24.02)	1,682,700	2,403,400
II-A Level 2	409,000 (13.63)	1,469,000	1,878,000
II-D Level 2	408,400 (13.61)	1,473,900	1,882,300
II-E Level 2	392,600 (13.09)	1,461,700	1,854,300
II-A Level 3	351,800 (11.73)	1,394,000	1,745,800
II-D Level 3	331,800 (11.06)	1,401,900	1,733,700
II-E Level 3	287,500 (9.58)	1,240,700	1,528,200
III-A Level 1	542,000 (18.07)	772,000	1,314,000
III-E Level 1	513,000 (17.10)	799,000	1,312,000
IV-A Level 3	336,000 (11.20)	1,450,000	1,786,000
IV-D Level 3	361,800 (12.06)	1,450,000	1,811,800
IV-E Level 3	288,600 (9.62)	1,450,000	1,738,600
V-E Level 3	310,600 (10.35)	1,450,000	1,760,600

Note: The numbers appearing in parentheses indicate the monthly cost per household, assuming 2,500 houses within the District.

Table 5.5

PRESENT WORTH SUMMARY FOR WASTEWATER
MANAGEMENT ALTERNATIVES
(in dollars)

<u>System</u>	<u>LDSD #1</u>	<u>HMC</u>	<u>Total</u>
I-A Level 1	12,981,000	7,254,000	20,235,000
I-D Level 1	13,491,000	7,254,000	20,745,000
I-E Level 1	11,430,000	7,254,000	18,684,000
I-A Level 2	11,804,000	6,676,000	18,480,000
I-D Level 2	12,679,000	6,676,000	19,355,000
I-E Level 2	10,341,000	6,676,000	17,017,000
I-A Level 3	9,621,000	6,676,000	16,297,000
I-D Level 3	10,767,000	6,676,000	17,443,000
I-E Level 3	7,628,000	6,676,000	14,304,000
II-A Level 1	16,831,000	10,128,000	26,959,000
II-D Level 1	16,677,000	10,441,000	27,118,000
II-E Level 1	16,086,000	9,991,000	26,078,000
II-A Level 2	10,864,000	7,678,000	18,542,000
II-D Level 2	11,445,000	7,712,000	19,157,000
II-E Level 2	9,391,000	7,591,000	16,169,000
II-A Level 3	9,301,000	6,868,000	16,169,000
II-D Level 3	9,961,000	6,949,000	16,910,000
II-E Level 3	7,235,000	6,256,000	13,491,000
III-A Level 1	15,972,000	8,864,000	24,836,000
III-E Level 1	14,394,000	9,183,000	23,577,000
IV-A Level 3	13,626,000	6,676,000	20,302,000
IV-D Level 3	14,644,000	6,676,000	21,320,000
IV-E Level 3	11,726,000	6,676,000	18,402,000
V-E Level 3	10,877,000	6,676,000	17,553,000

Table 5.6

PROJECT COSTS AND GRANT REQUIREMENTS FOR
WASTEWATER MANAGEMENT ALTERNATIVES
(in dollars)

System	LDSD #1		HMC		Total	
	Project Cost	Grant Requirement	Project Cost	Grant Requirement	Project Cost	Grant Requirement
I-A Level 1	9,123,000	7,298,000	4,955,000	-	14,078,000	7,298,000
I-D Level 1	9,971,000	7,977,000	4,955,000	-	14,926,000	7,977,000
I-E Level 1	7,391,700	5,913,000	4,955,000	-	12,346,700	5,913,000
I-A Level 2	8,795,000	7,036,000	4,547,000	-	13,342,000	7,036,000
I-D Level 2	9,746,000	7,797,000	4,547,000	-	14,293,000	7,797,000
I-E Level 2	7,171,700	5,737,000	4,547,000	-	11,718,700	5,737,000
I-A Level 3	7,467,000	5,974,000	4,547,000	-	12,014,000	5,974,000
I-D Level 3	8,592,000	6,873,000	4,547,000	-	13,139,000	6,873,000
I-E Level 3	5,517,700	4,414,000	4,547,000	-	10,064,700	4,414,000
II-A Level 1	11,778,000	9,422,000	6,885,000	2,178,000	18,663,000	11,600,000
II-D Level 1	12,176,000	9,740,000	7,087,000	2,341,000	19,263,000	12,081,000
II-E Level 1	10,570,200	8,456,000	6,767,000	2,084,000	17,337,200	10,540,000
II-A Level 2	8,163,000	6,530,000	5,260,000	878,000	13,423,000	7,408,000
II-D Level 2	8,898,000	7,118,000	5,244,000	865,000	14,142,000	7,983,000
II-E Level 2	6,545,700	5,237,000	5,201,000	832,000	11,746,700	6,069,000
II-A Level 3	6,962,000	5,569,000	4,722,000	448,000	11,684,000	6,017,000
II-D Level 3	8,056,000	6,445,000	4,770,000	486,000	12,826,000	6,931,000
II-E Level 3	5,238,700	4,190,000	4,130,000	425,000	9,368,700	4,616,000
III-A Level 1	12,783,000	10,226,000	7,068,000	5,654,000	19,851,000	15,880,000
III-E Level 1	11,194,200	8,955,000	7,327,000	5,862,000	18,521,200	14,817,000
IV-A Level 3	12,582,000	10,066,000	4,547,000	-	17,129,000	10,066,000
IV-D Level 3	13,515,000	10,812,000	4,547,000	-	18,062,000	10,812,000
IV-E Level 3	10,836,100	8,668,900	4,547,000	-	15,383,100	8,668,900
V-E Level 3	9,482,500	7,586,000	4,547,000	-	14,029,500	7,586,000

All the Wastewater Management System IV alternatives were eliminated from further consideration because of a potential legal restriction against constructing a pipeline through Centennial Valley. In a November 15, 1974, Stipulation between the Save Centennial Valley Association, EPA, and the District, the District agreed to abandon the valley as a potential waste treatment or transport site.

A review of cost information indicated that the Level 1 treatment alternatives for Wastewater Management System II--II-A(1), II-D(1), and II-E(1)--had the highest annual costs to the District. These alternatives were therefore no longer considered viable alternatives. The rest of the alternatives for the physical-chemical treatment System II were also eliminated, because HMC felt that the EPA would require extensive and expensive pretreatment systems.

The Level 2 alternatives for the advanced biological treatment system, Wastewater Management System I, were eliminated because they were more expensive than the Level 3 System I alternatives and had no advantages over the Level 3 alternatives in their abilities to meet the effluent limitations. The major difference between the two treatment levels under a biological system is that Level 2 treatment for the District has a higher removal of suspended solids material and residual chlorine, along with an increase in the effluent dissolved oxygen level. The System I Level 2 alternatives would produce an effluent of superior quality than any of the other treatment systems considered for Level 3. However, they would still not produce a high enough quality effluent to allow the establishment of a cold water fishery within Whitewood Creek, primarily due to the potential ammonia-nitrogen concentration found in the effluent.

Of the remaining alternatives, all those with flow reduction A or D were eliminated. Based on the economic analysis, the most cost-effective flow reduction method would be E, which utilizes the existing Lead collection system with a bypass structure. During review meetings held in Spearfish and Rapid City, it was agreed to eliminate the other flow reduction alternatives and consider only the E alternative systems.

In making this selection, it was recognized that Alternative E provides for the discharge of combined sanitary and storm flows (without treatment) to the stream. Alternatives A and D were eliminated primarily because of (1) their relatively high costs and (2) the major construction and disruption that their implementation would cause in Lead.

Implementation of Alternative E would allow future action based on a better definition and demonstration of the corrective

measures needed. It is probable that some form of action (as described in Alternatives A and D) would be needed in the future. Alternative E would keep several options (for the phasing of corrective measures) open.

As a result of the screening, four wastewater management systems remained for more detailed analysis:

- Lower Deadwood Advanced Wastewater Treatment (AWT) System--I-E(1).
- Lower Deadwood Secondary Treatment System--I-E(3).
- Grizzly Gulch Land-based Treatment System--III-E(1).
- Slaughterhouse Gulch Lagoon System--V-E(3). (Note: This alternative was defined late in the planning procedure and has not been included in the competitive evaluation. Additional study will be made if necessary only if water quality standards are modified by the State of South Dakota to allow consideration of this alternative.)

These wastewater management alternatives, with the exception of the Slaughterhouse Gulch Lagoon System--V-E(3), are described in detail in the next chapter. The comparative evaluation, phase four of the general planning procedure, is presented in Chapter 7.

DEVELOPMENT AND EVALUATION OF ALTERNATIVES

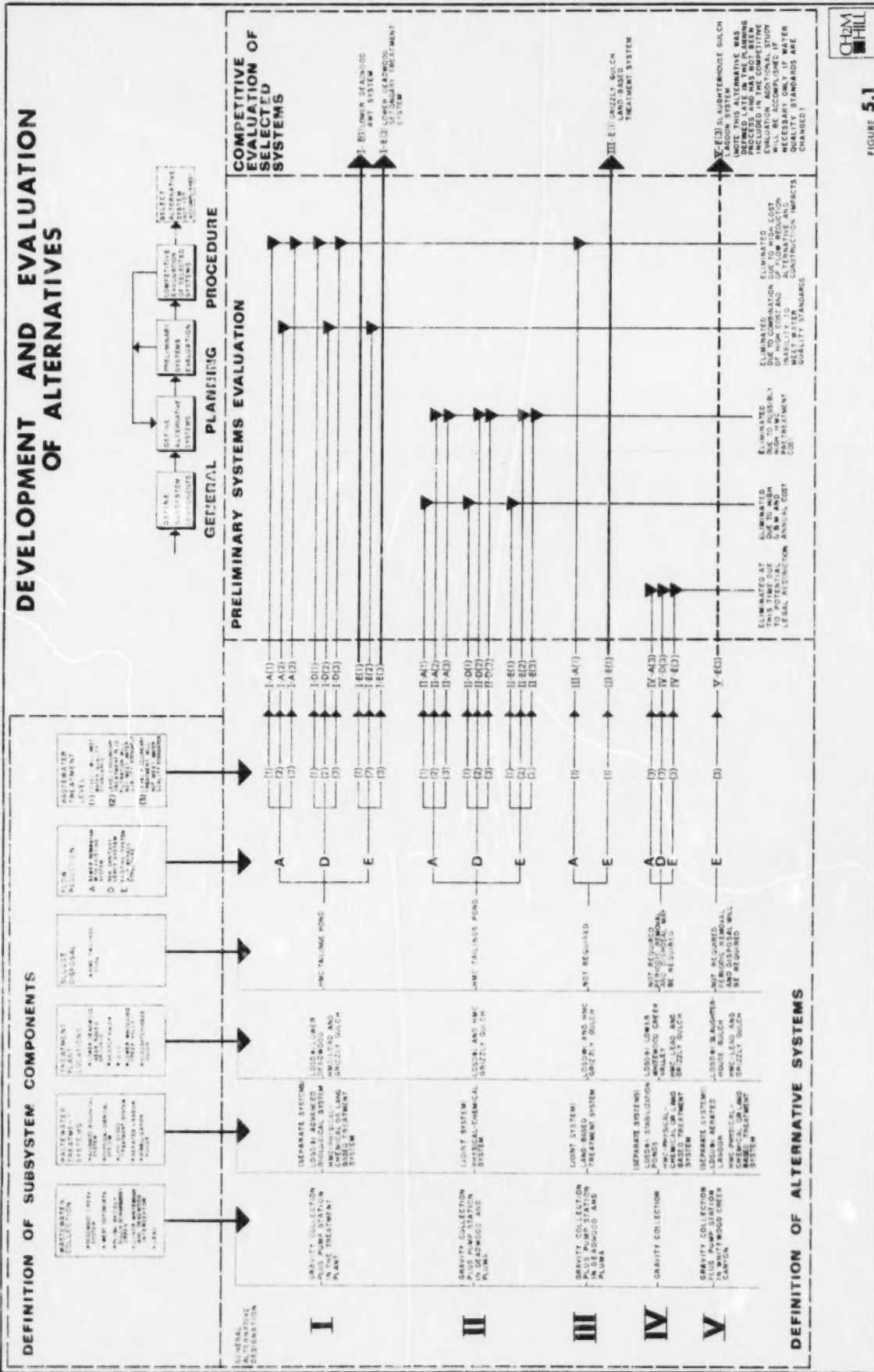
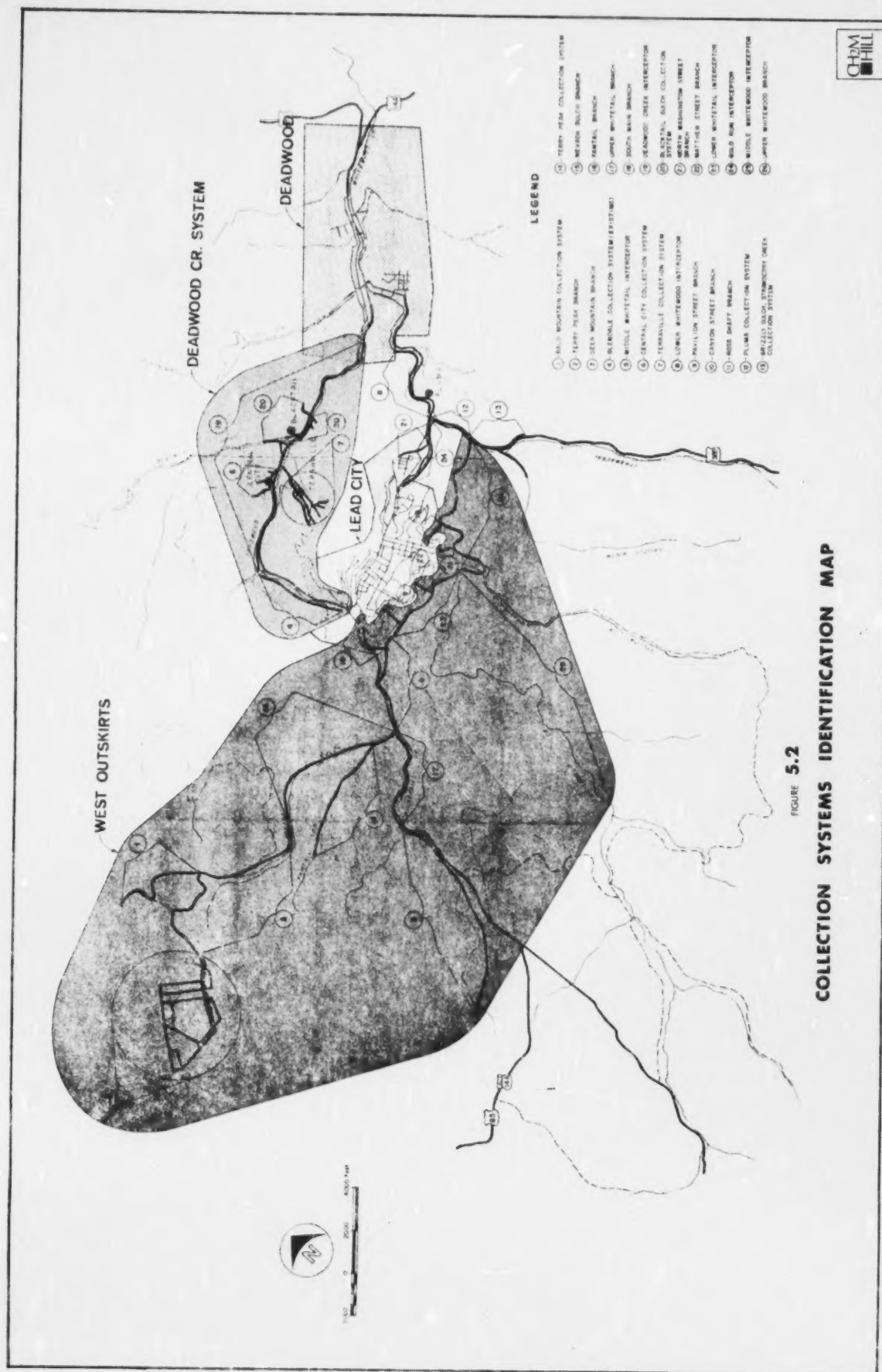


FIGURE 5.1



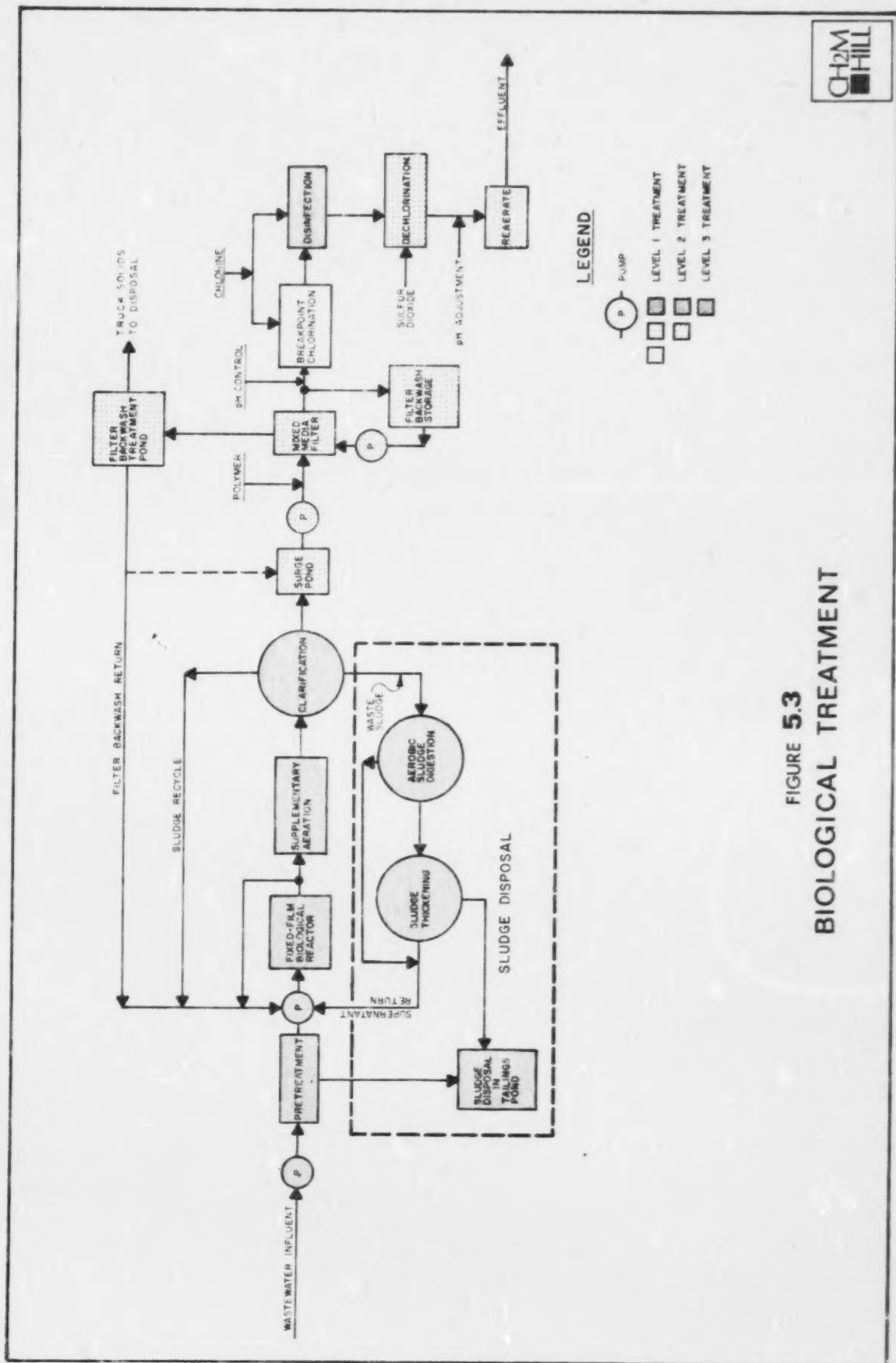


FIGURE 5.3
BIOLOGICAL TREATMENT

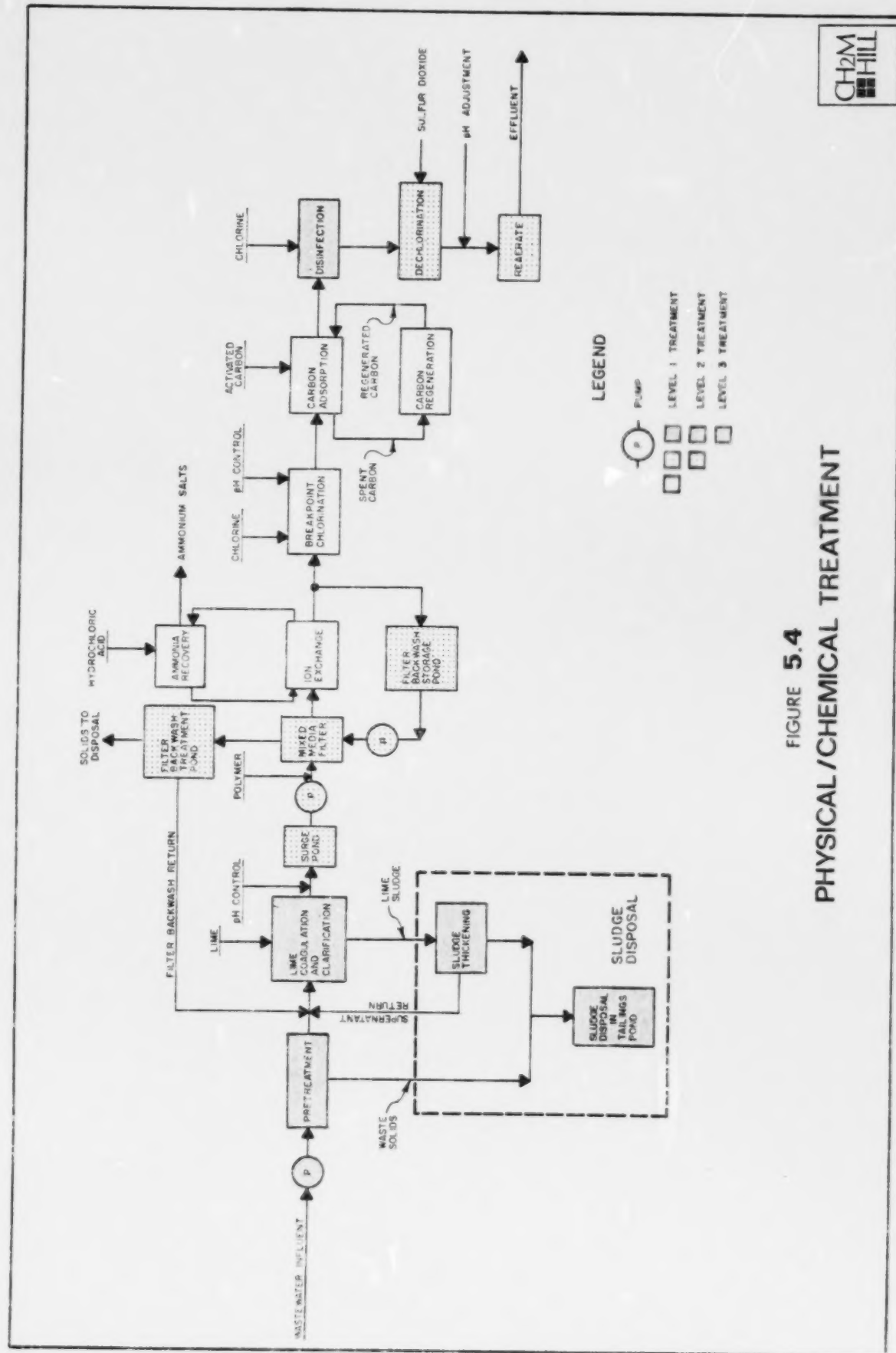


FIGURE 5.4
PHYSICAL/CHEMICAL TREATMENT

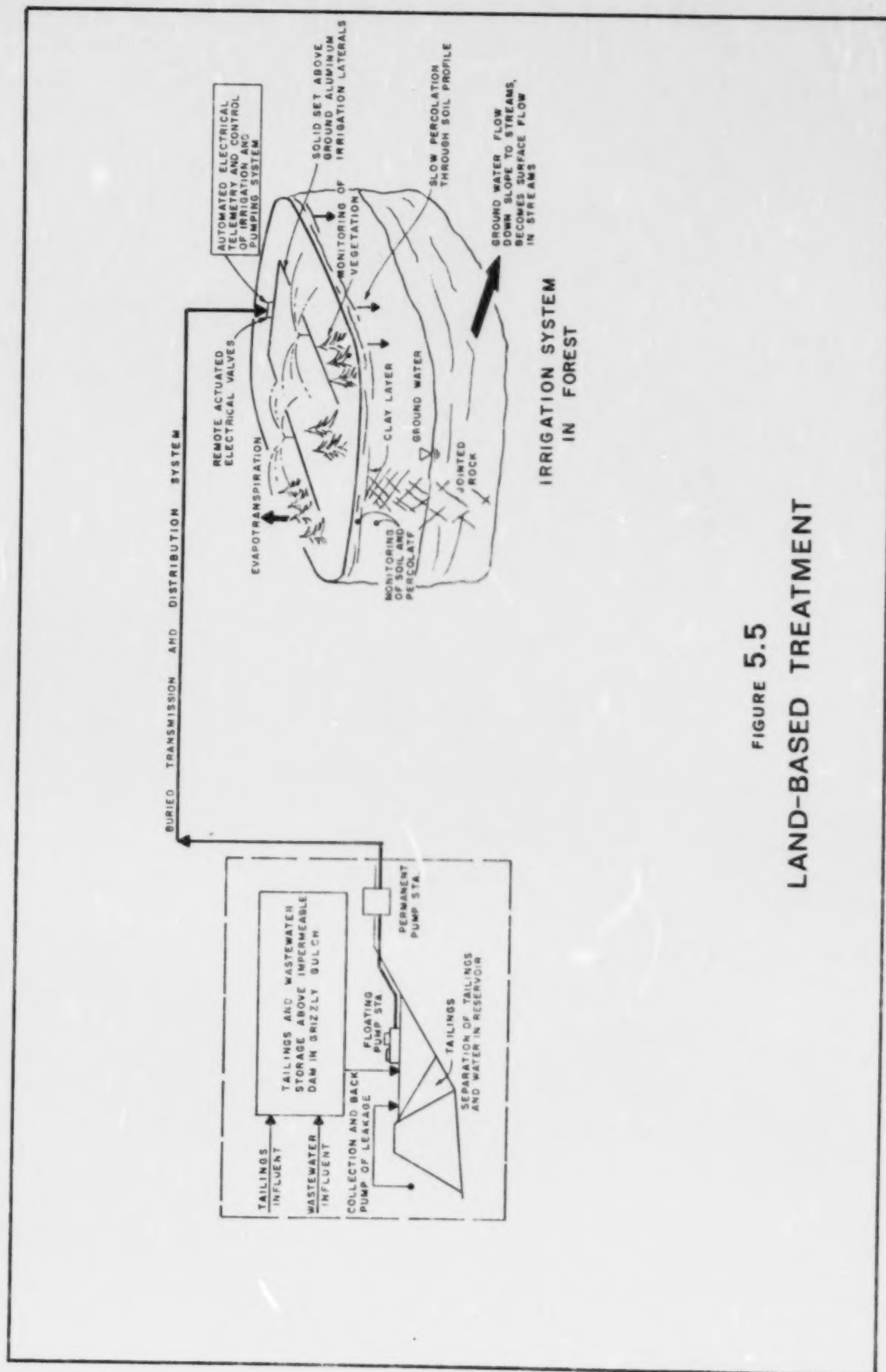


FIGURE 5.5
LAND-BASED TREATMENT

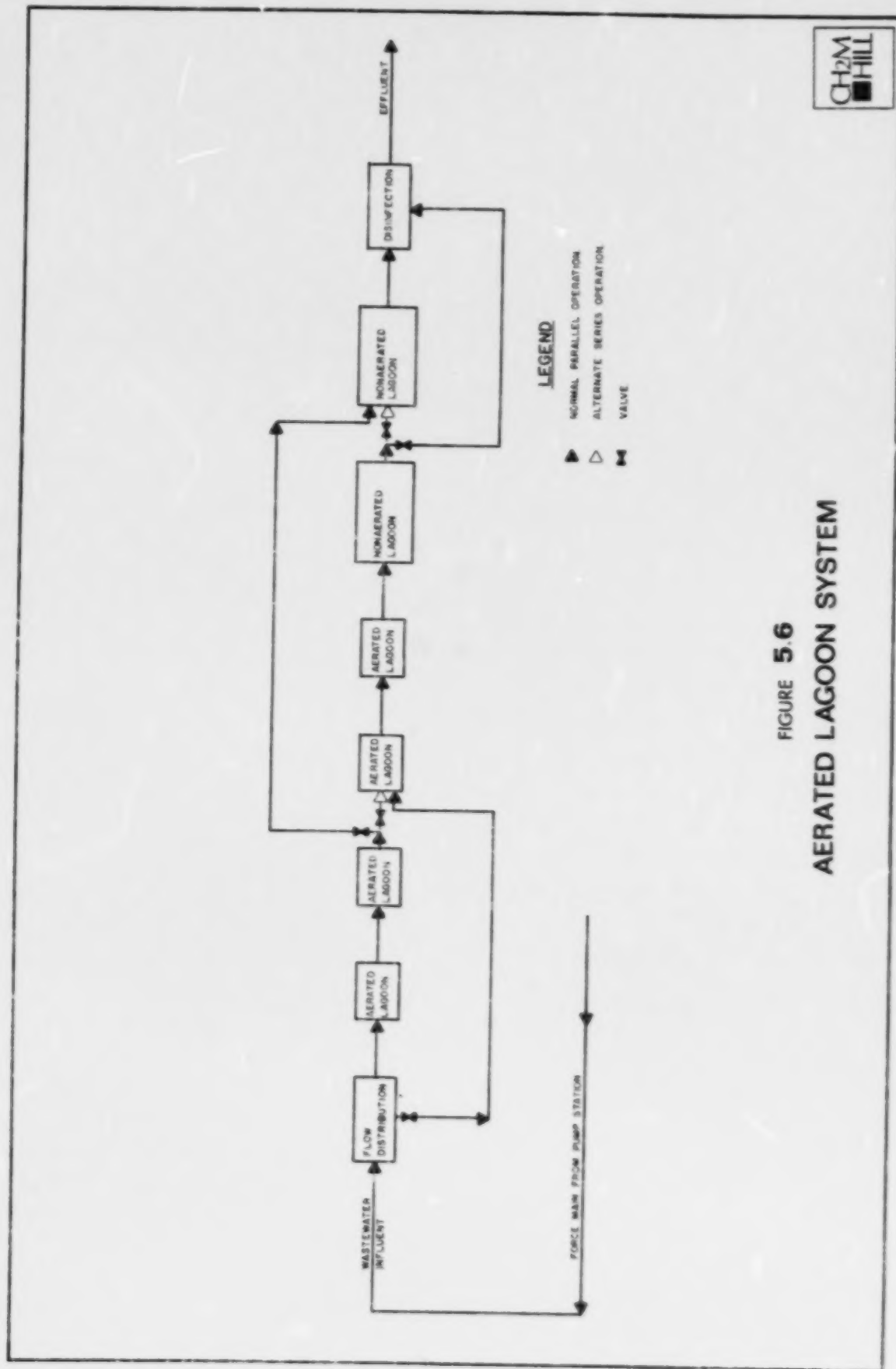


FIGURE 5.6
AERATED LAGOON SYSTEM



FIGURE 5.7
STABILIZATION PONDS

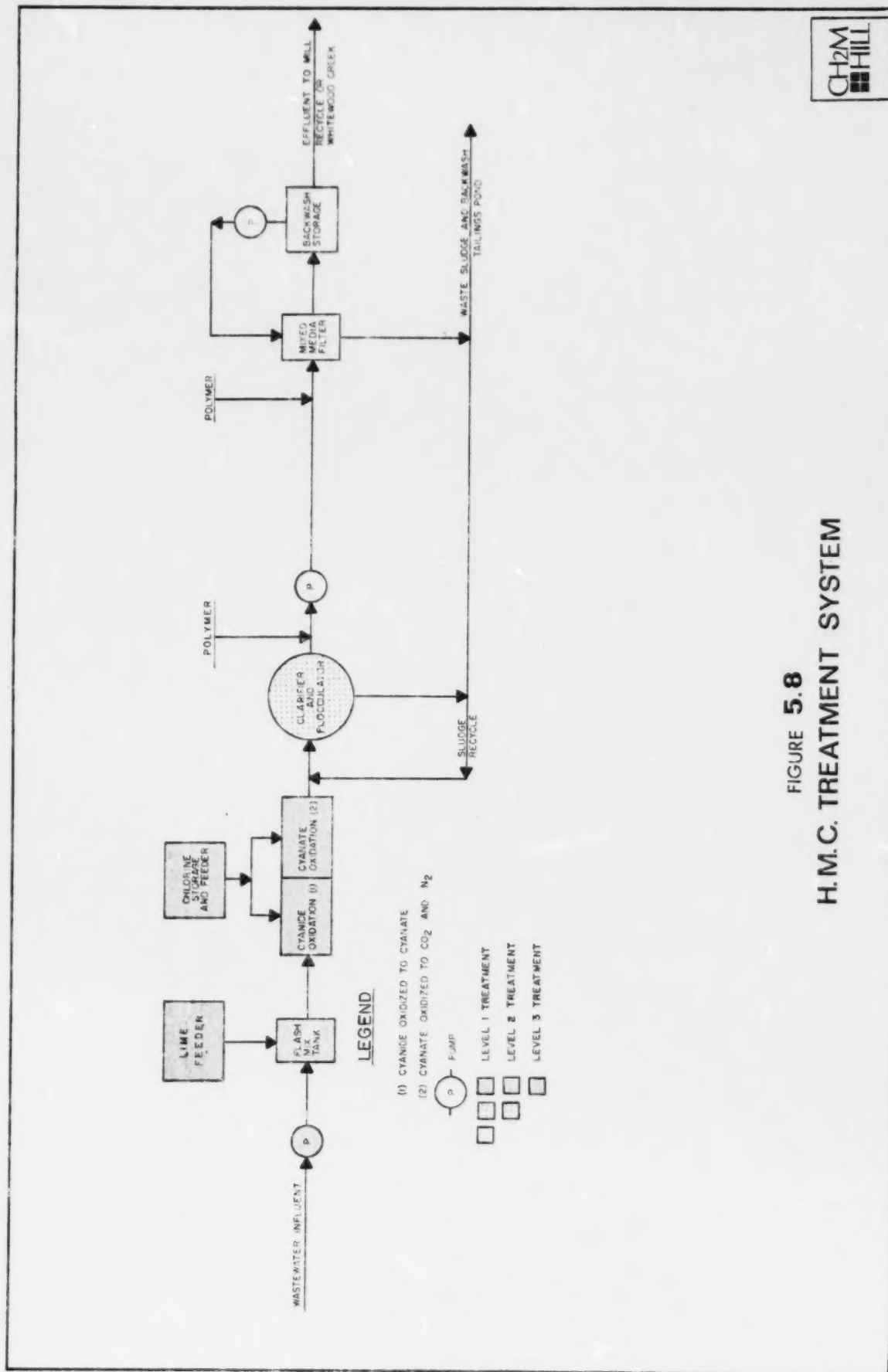


FIGURE 5.8
H.M.C. TREATMENT SYSTEM

MAJOR TASKS OF ALTERNATIVE 'A'

- CONSTRUCT A NEW SANITARY TRUNK SEWER ALONG LEAD'S JULIUS STREET.
- CONSTRUCT NEW STORM WATER BRANCH AND LATERAL SEWERS TO SERVE LEAD'S EXISTING CATCH BASINS.

NOTES:

- (1) LEAD'S EXISTING BRANCH AND LATERAL SEWERS WILL SERVE AS SEPARATE SANITARY SEWERS.
- (2) THE EXISTING JULIUS STREET TRUNK SEWER WILL SERVE AS A SEPARATE STORM SEWER.

LEGEND:

— NEW SEWER PIPING.

- - - EXISTING SEWER PIPING.

▤ EXISTING STORM WATER CATCH BASIN.

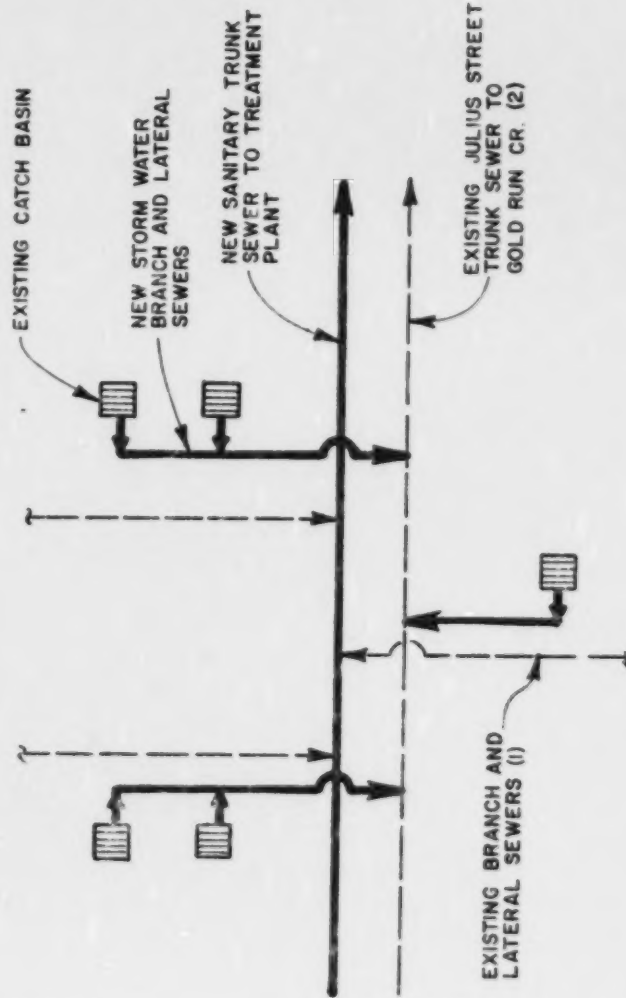
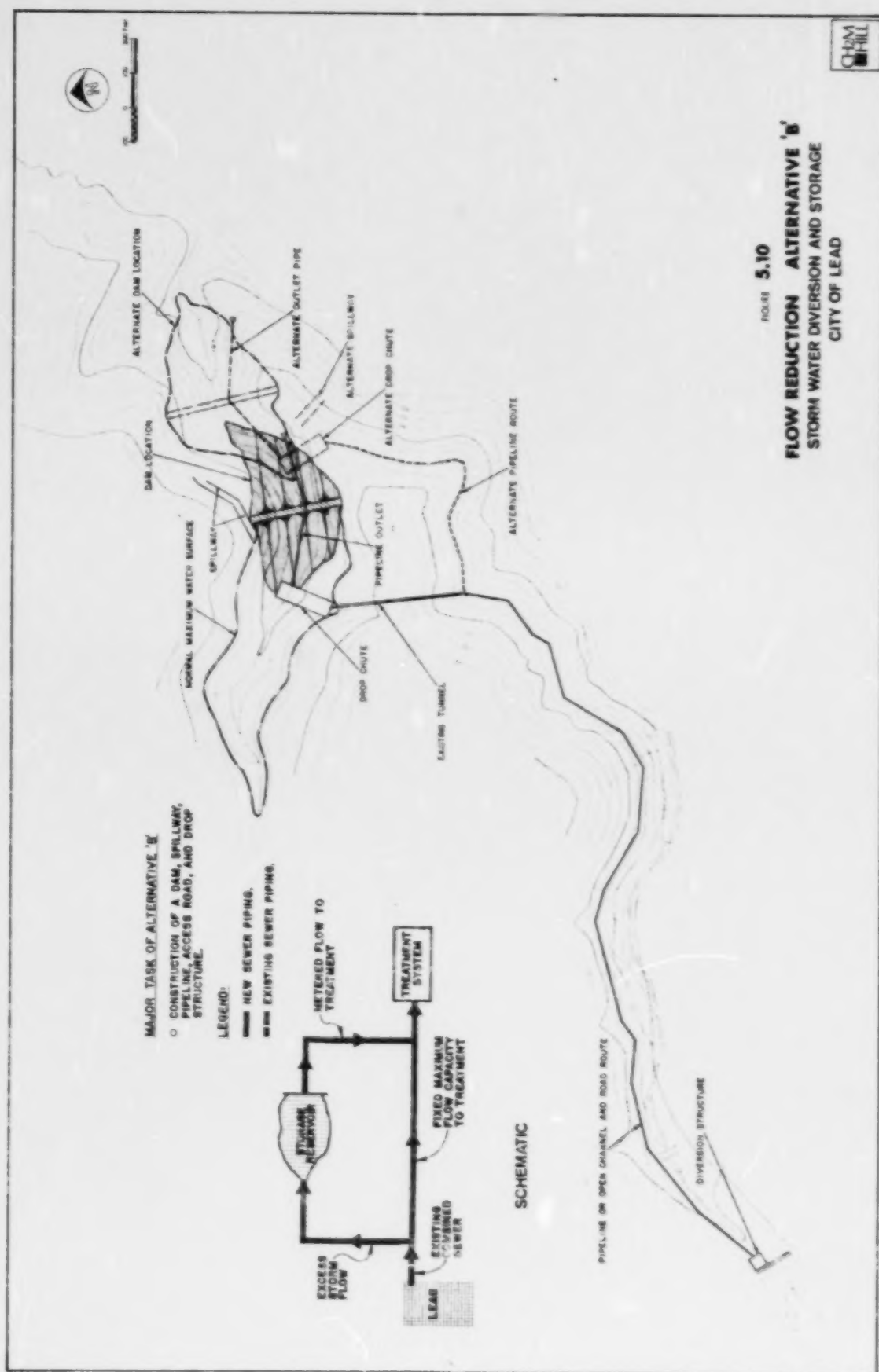


FIGURE 5.9

SCHEMATIC-FLOW REDUCTION ALTERNATIVE 'A'

NEW SANITARY TRUNK SEWER AND NEW STORM WATER BRANCH-LATERAL SEWERS
CITY OF LEAD

FIGURE 5.10
FLOW REDUCTION ALTERNATIVE 'B'
STORM WATER DIVERSION AND STORAGE
CITY OF LEAD



MAJOR TASK OF ALTERNATIVE 'C'

- CONSTRUCT A COMPLETELY NEW STORM SEWER SYSTEM.

NOTES:

- (1) LEAD'S EXISTING COMBINED SEWER SYSTEM WILL SERVE AS A SEPARATE SANITARY SEWER SYSTEM.

LEGEND:

— NEW SEWER PIPING.

- - - EXISTING SEWER PIPING



EXISTING STORM WATER CATCH BASIN

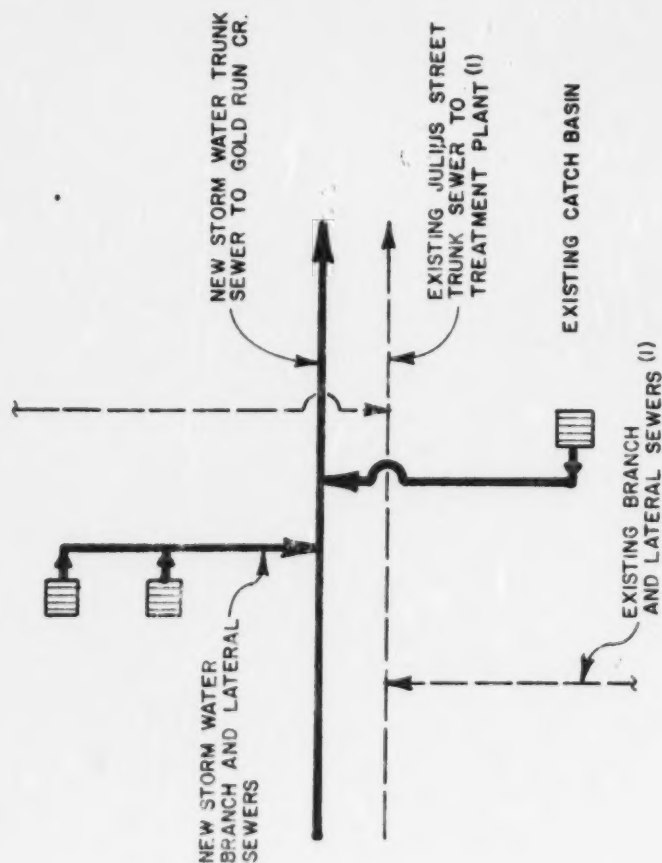


FIGURE 5.11
SCHEMATIC-FLOW REDUCTION ALTERNATIVE 'C'
NEW STORM SEWER SYSTEM
CITY OF LEAD

MAJOR TASKS OF ALTERNATIVE 'D'

- O CONSTRUCT A NEW SANITARY TRUNK SEWER ALONG JULIUS STREET.
- O CONSTRUCT A PARTIAL SANITARY BRANCH AND LATERAL SEWER SYSTEM. INTEGRATE NEW SANITARY SEWERS WITH EXISTING SEWERS WHERE SEPARATE STORM SEWER PIPING IS NOT REQUIRED.

NOTE:

- (1) USE APPROPRIATE SEGMENTS OF EXISTING BRANCH AND LATERAL SEWER PIPING AS SEPARATE SANITARY SEWERS.

LEGEND:

- NEW SEWER PIPING.
- - - EXISTING SEWER PIPING
- ▨ EXISTING STORM WATER CATCH BASIN

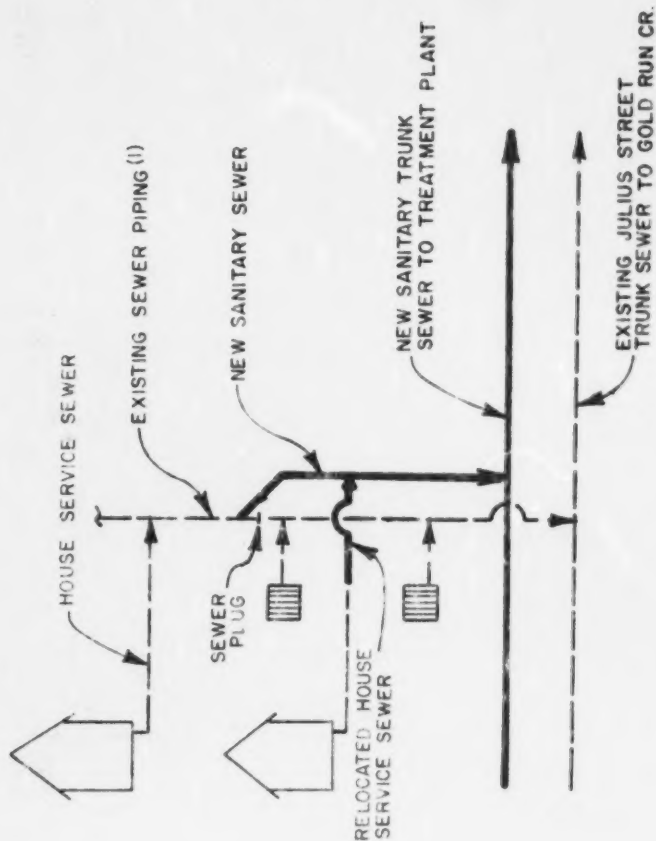


FIGURE 5.12
SCHEMATIC-FLOW REDUCTION ALTERNATIVE 'D'
NEW SANITARY SEWER SYSTEM
CITY OF LEAD

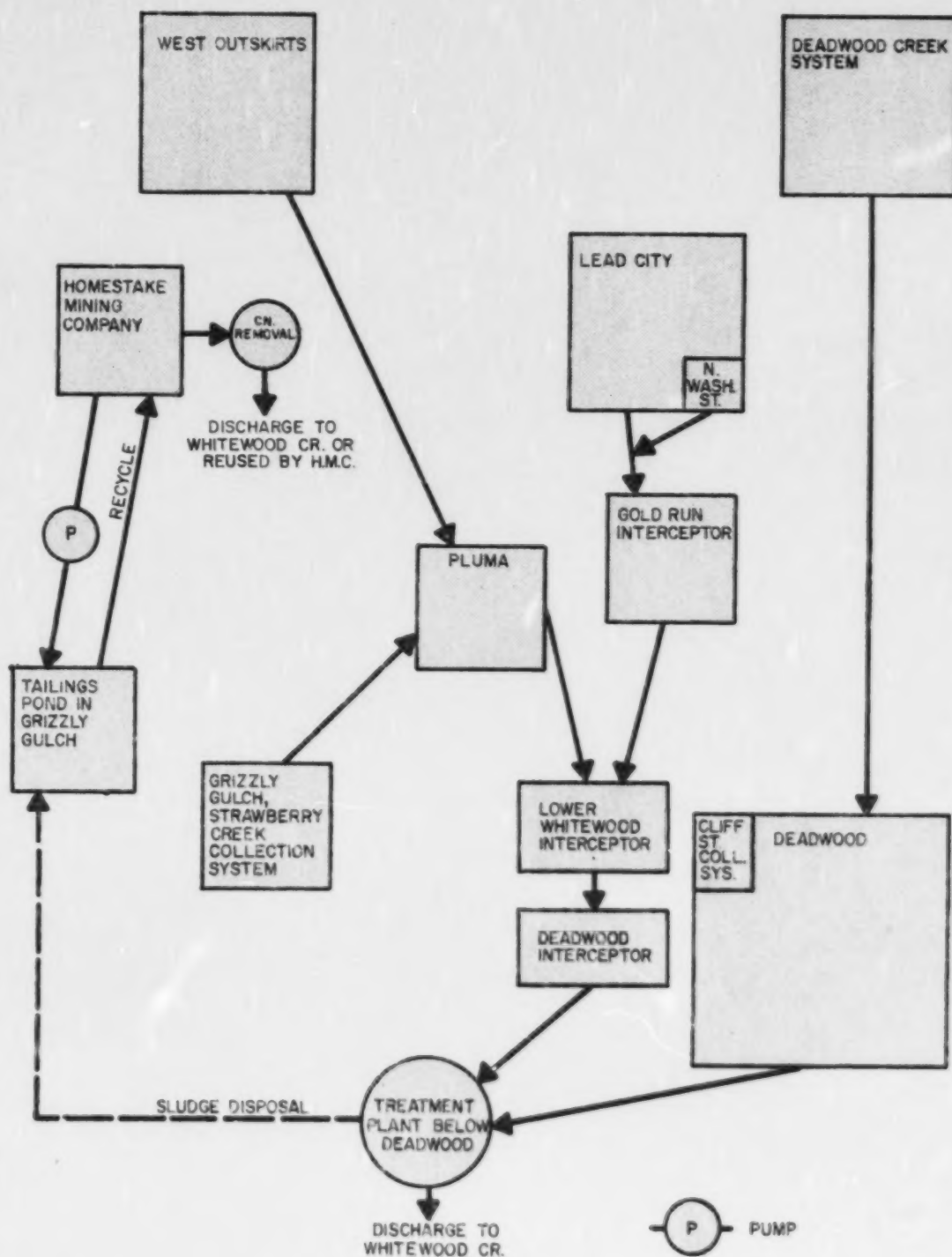


FIGURE 5.13

ALTERNATIVE WASTEWATER MANAGEMENT SYSTEM I

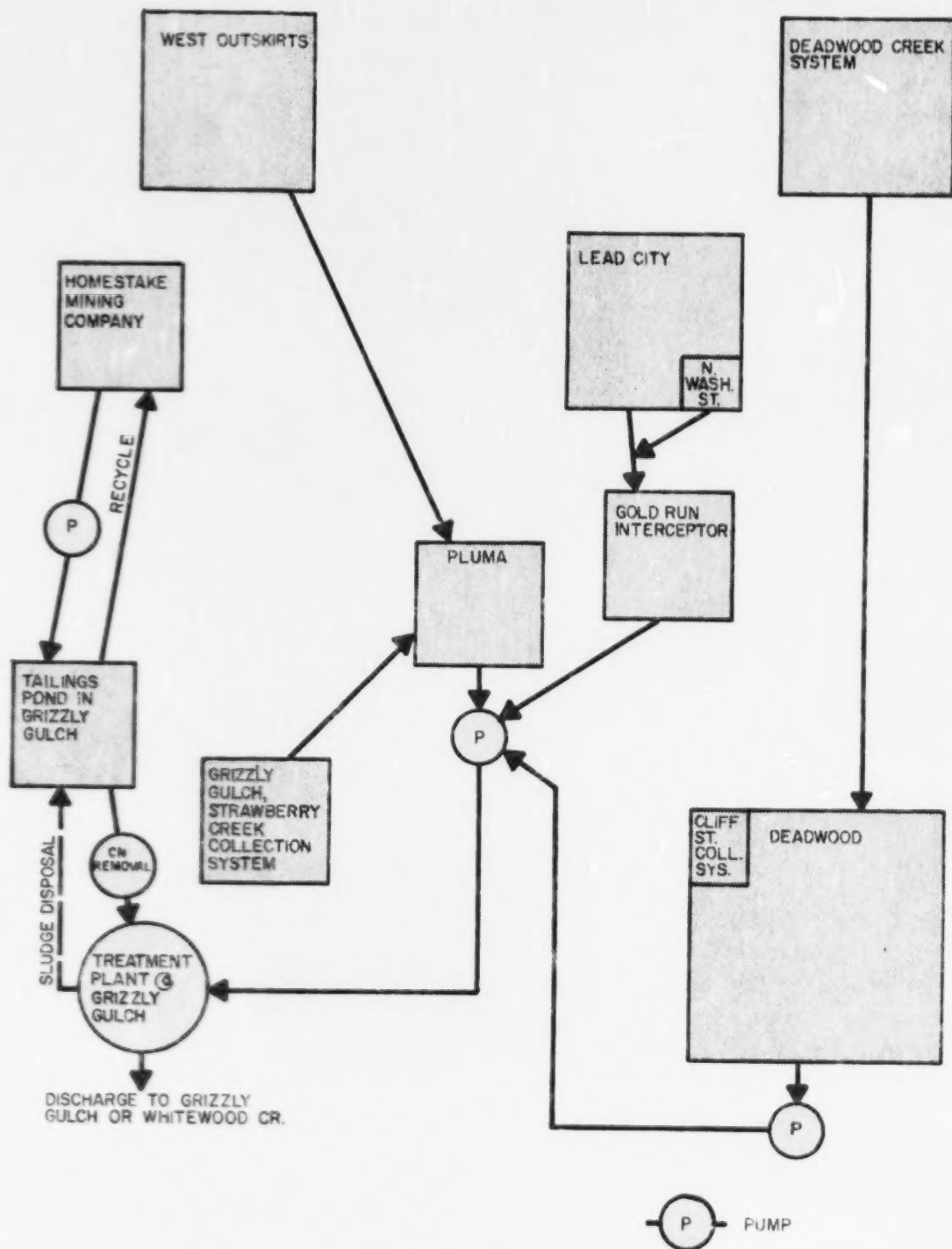


FIGURE 5.14
ALTERNATIVE WASTEWATER MANAGEMENT SYSTEM II

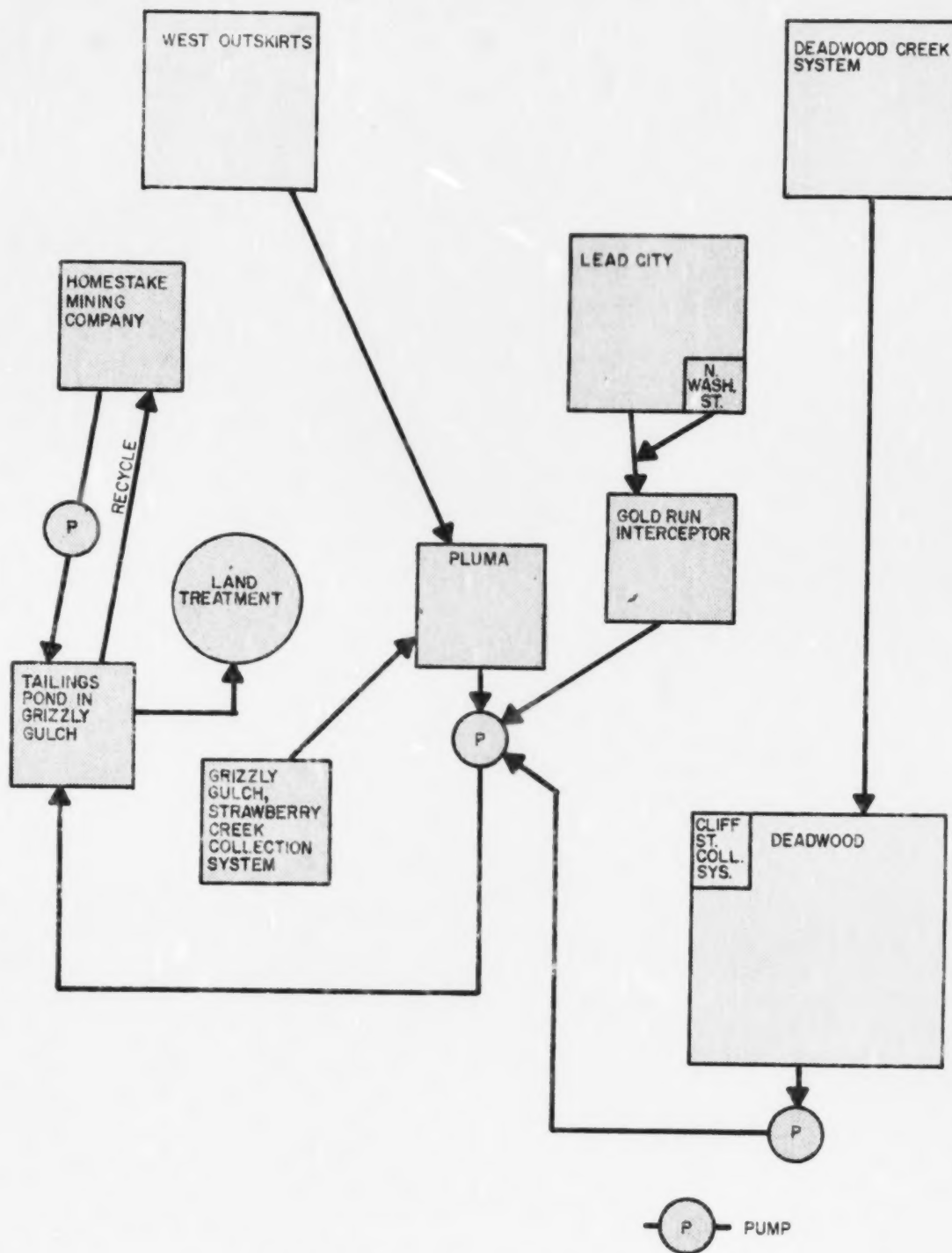
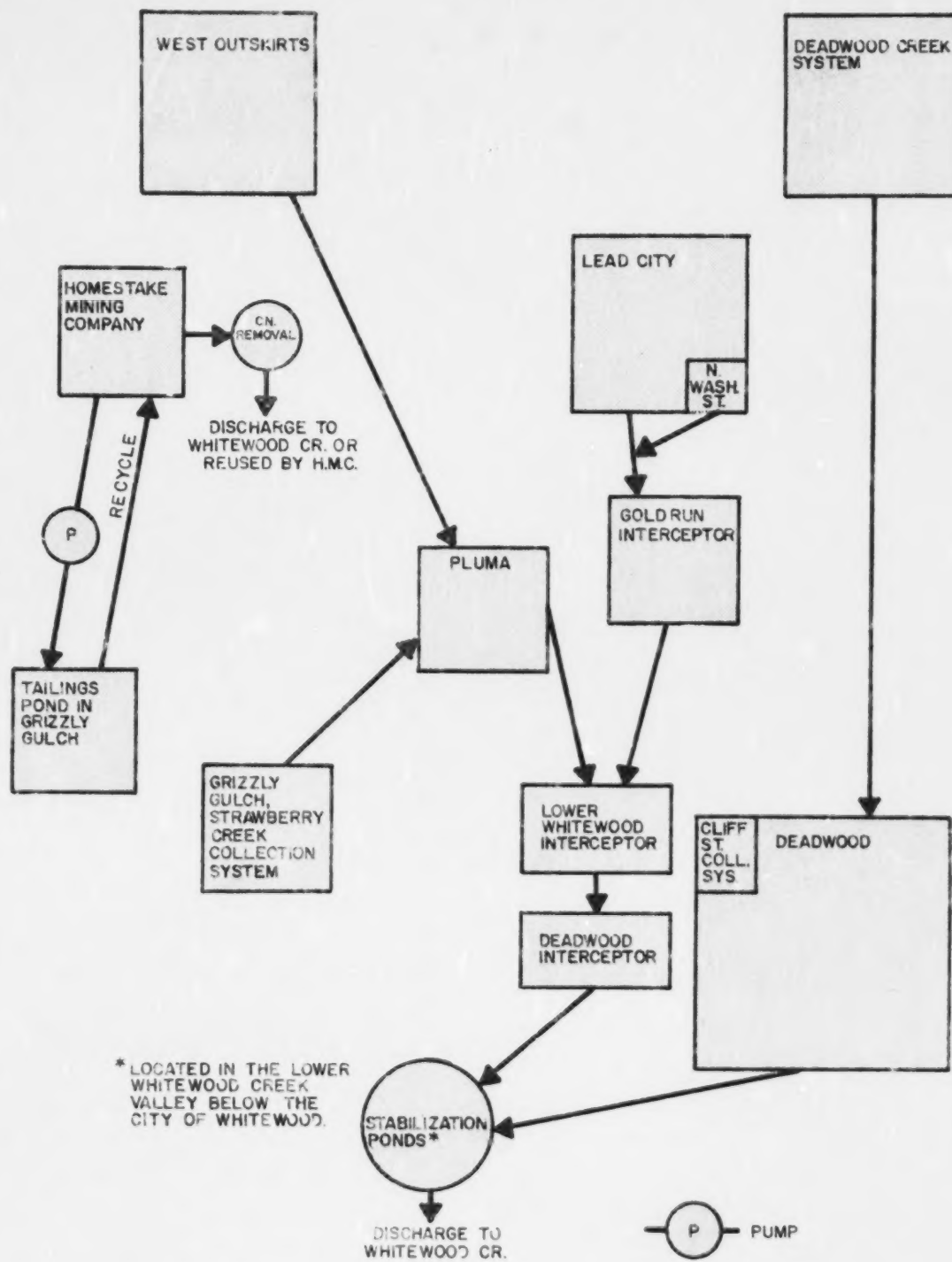


FIGURE 5.15
ALTERNATIVE WASTEWATER MANAGEMENT SYSTEM III



* LOCATED IN THE LOWER WHITEWOOD CREEK VALLEY BELOW THE CITY OF WHITEWOOD.

FIGURE 5.16

ALTERNATIVE WASTEWATER MANAGEMENT SYSTEM IV

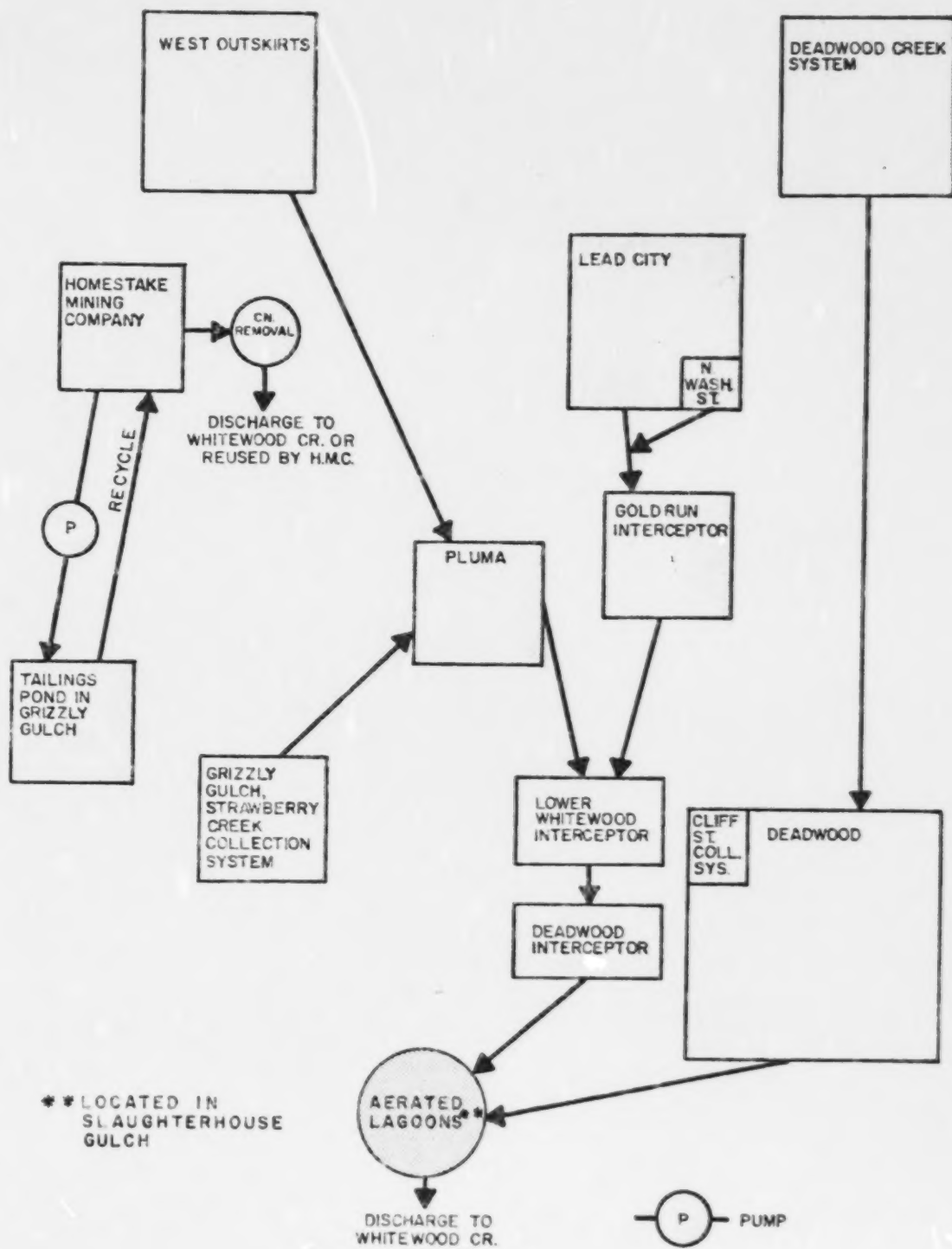


FIGURE 5.17

ALTERNATIVE WASTEWATER MANAGEMENT SYSTEM V

Chapter 6 DESCRIPTION OF ALTERNATIVES

This chapter presents detailed descriptions of the three wastewater management alternatives selected for the competitive evaluation. The collection system for all three alternatives would be basically the same. The options for treating HMC's wastes would also be the same for the two management alternatives that would provide separate treatment of municipal and industrial wastes. Instead of repeating the descriptions of these management components for each appropriate alternative, they are discussed in the following two sections.

COLLECTION SYSTEM

The proposed wastewater collection system would provide the same area of coverage for all three alternatives. The system would serve Lead, Deadwood, and surrounding areas. The outlying areas of Bald Mountain, Deer Mountain, and Terry Peak were not included because of the high cost associated with serving the few number of homes in these areas. Outlying areas included in the proposed collection system were combined into three major groups. The Deadwood Creek system would provide service to existing homes in the Deadwood Creek drainage basin. This system would also collect wastewater from the existing Glendale collection system located in northwest Lead. The west outskirts consist of five additional separate discharges from south Lead and other outlying areas southwest of Lead. The third major group consists of the Pluma, Strawberry Creek and Grizzly Gulch collection systems. The proposed collection system for the three alternatives is shown on Figures 6.1 and 6.4.

The major difference in the collection systems for the two different sites, lower Deadwood for systems I-E(1) and I-E(3) and Grizzly Gulch for system III-E(1), is a complete gravity flow system versus a collection system involving pump stations and force mains. A gravity flow collection system can be utilized if a treatment plant were located in lower Deadwood. The combined treatment system in Grizzly Gulch would require two pump stations: one in lower Deadwood and one in Pluma.

HMC WASTE TREATMENT

Under the management systems providing separate municipal and industrial treatment, I-E(1) and I-E(3), HMC would treat its own wastes, either in a physical-chemical treatment plant in Lead or through a land-based treatment system in the Grizzly Gulch vicinity. HMC would also construct a tailings pond in Grizzly Gulch and pipelines between the HMC mill and the pond to transport the tailings and recycle excess sluice water.

An extremely important part of the wastewater control program in the Lead-Deadwood area will be the institution of a flow reduction scheme within HMC. Preliminary investigations by HMC have indicated a possible flow reduction of 4 mgd, resulting in effluent of 1 mgd to be treated for discharge into the area streams. Because the recycle system to be implemented has not yet been defined, the exact flow and characteristics of the effluent to be treated cannot be estimated. As a result, potential treatment systems for HMC cannot yet be definitively investigated or developed. Because of the expected complex nature of the wastewater, pilot testing will probably be required. A preliminary evaluation of potential HMC treatment systems has been made in the Task 13 report included in the appendices.

LOWER DEADWOOD AWT SYSTEM--I-E(1)

Under alternative I-E(1) the District's wastewaters would be treated in an AWT plant located in lower Deadwood near the rodeo grounds, as shown on Figure 6.1. This plant would provide pretreatment, secondary and tertiary treatment, disinfection, and sludge handling and disposal facilities. The various unit processes, identified on Figure 6.2, are described below, along with the required pumping facilities. Tables itemizing the design criteria are included in the descriptions.

PRETREATMENT FACILITIES

Raw Sewage Pump Station

A raw sewage pump station with an estimated capacity of 7.3 mgd would lift the wastewater from the gravity interceptor to the pretreatment system. The pump station, not shown on Figure 6.2, may be located near the bridge to the rodeo grounds and would have its own standby power system to provide protection against flow bypassing during power outages.

Vertical Screens

Vertical screens would collect and remove solids from the raw wastewater. The effluent would flow by gravity to Pump Station No. 2. The screened solids would be thoroughly ground and pumped to the aerobic digesters or a waiting dump truck for disposal in the tailings pond or sanitary landfill.

SECONDARY FACILITIES

Pump Station No. 2

Pump Station No. 2 would blend the pretreated effluent with return flows from the fixed film biological reactors, supernatant from the aerobic digesters, sludge recycle from the secondary clarifiers, and filter backwash from the mixed media filters. This pump station would have its own standby power system and an estimated pumping capacity of 9.3 mgd.

Activated Biological Filter System

The activated biological filter system (ABF) is a combination of the trickling filter and activated sludge processes. During this secondary treatment, organic material and ammonia would be oxidized and the organic matter would be consumed by bacteria. Wastewater would be distributed over the top of the filter media by a fixed nozzle distribution system, and a portion of the underflow would be recycled (along with the settled sludge from the secondary clarifiers) to Pump Station No. 2. Effluent from the filter towers would flow by gravity into two aeration basins, where the organic matter would be further broken down by bacteria. Design criteria for the ABF system are listed in Table 6.1.

Air would be moved through the towers by natural air convection currents. Unless the towers are severely overloaded, this air movement is sufficient to avoid any potential odor problems. However, fans would be provided to increase the amount of air moving through the towers, and the exhaust air would be scrubbed to further control odors.

Blowers located in Pump Station No. 2 would supply air for a diffused aeration system in the aeration basins. The standby power unit in Pump Station No. 2 would be large enough to provide standby power for the pumps and the 115 horsepower required by the blowers.

Secondary Clarifiers

Suspended solid material would be removed by gravity in two circular clarifiers designed as indicated in Table 6.2. To prevent sludge denitrification and its resulting floating sludge, rapid sludge removal mechanisms would be employed.

Table 6.1

ACTIVATED BIOLOGICAL FILTER SYSTEM DESIGN CRITERIA

Filter Towers

Number of Towers	2
Average BOD Load	1,600 lbs BOD/day
Average Volumetric BOD Loading	60 lbs/1,000 ft ³ /day

Aeration Basins

Number of Basins	2
Total Liquid Volume	0.45 million gallons
Detention Times	
At Average Daily Flow of 2.44 mgd	4.5 hrs.
At Maximum Daily Flow of 3.3 mgd	3.0 hrs.
Average BOD Load to Basins ⁽¹⁾	650 lbs/day
Average Waste Sludge Production (Dry Solids)	1,000 lbs/day
Average Sludge Recycle Rate	70%

Aeration Equipment

Type	Rotary, Positive Displacement
Number	2
Horsepower	115

(1) Based upon 60% BOD removal in filter towers.

Table 6.2

SECONDARY CLARIFIER DESIGN CRITERIA

Number	2
Diameter	60 feet
Sidewater Depth	14 feet
Overflow Rate	
Average Daily Flow of 2.44 mgd	430 gpd/ft ²
Maximum Daily Flow of 3.3 mgd	580 gpd/ft ²

Scum and grease would be removed from the surface of the secondary clarifiers with scum skimmer arms. To remove the scum from the treatment process, scum pumps would deliver the scum from a common collection pit to the aerobic digesters or a hopper for direct disposal of the sludge in the tailings pond. The scum pump station would include facilities to dewater the clarifiers, aeration basins, aerobic digesters and air flotation units.

TERTIARY FACILITIESSurge Pond

The clarified effluent would enter a surge pond. A surge pond equalizes or evens out the daily flow fluctuations, resulting in greater reliability, efficiency, and smaller unit sizes for the downstream facilities. The pond would accommodate one-half of the peak daily flow.

Pump Station No. 3

Pump Station No. 3 would pump effluent from the surge pond to the mixed media filters. This pump station would also have its own standby power system, along with chemical metering equipment to allow the addition of alum and polyelectrolytes to aid in the filtration of the effluent.

Mixed Media Filters

Filtration of the effluent from the surge pond would be accomplished by mixed media filters with a loading rate of 3 to 6 gpm per square foot. The filtration complex would have facilities for the addition of filter aids, such as alum or polyelectrolytes, which coagulate or floc the smaller particles together for more efficient filtration. Instruments for the operation and control of the filters, such as an automatic backwashing system and continuous monitoring and recording equipment, would also be provided.

Filter Backwash Storage Tank

Water for backwashing the filters would be stored in a 60,000-gallon tank. A constant speed pump with a capacity of 1,900 gpm would deliver water to backwash the filters. The maximum anticipated filter backwash time would be 30 minutes, with normal backwashing times of 15 minutes expected. Treatment plant effluent would be used as backwash water.

Filter Backwash Treatment Pond

An earthen pond would store the filter backwash. The 60,000-gallon pond would serve as a settling basin for the residues and suspended solid materials removed by the filters and as an equalization pond for storing backwash water prior to returning it to the treatment system at Pump Station No. 2.

BREAKPOINT CHLORINATION, DISINFECTION, AND DECHLORINATION SYSTEMS

The breakpoint chlorination system for the oxidation of ammonia-nitrogen, the disinfection system, and the dechlorination system would be combined into one structure. This structure, located immediately downstream from the mixed media filters, would contain three basins, one for each of the three systems. The breakpoint chlorination basin would have an average detention time of 8.8 minutes; the disinfection basin, an average detention time of 60 minutes; and the dechlorination basin, an average detention time of 15 minutes. Table 6.3 lists the design criteria for these three systems.

The pH of the flow into the breakpoint chlorination basin would be monitored and adjusted with sodium hydroxide. Water in the breakpoint chlorination basin would be mixed by a mechanical flash mixer or a high intensity paddle mixer to ensure uniform distribution of the chlorine.

For disinfection, 5 to 8 mg/l of chlorine would be added before the effluent is discharged into a 1-hour contact basin. Plant water would be supplied from this basin by a 1,000 gpm pump. This water would be used for chlorine injection, pump seal water, irrigation, scum spray control, cooling water, washdown water and other miscellaneous plant uses.

Sulphur dioxide would be used for dechlorination. The effluent pH would be monitored and adjusted with sodium hydroxide in the reaeration basin.

Table 6.3

**BREAKPOINT CHLORINATION, DISINFECTION AND
DECHLORINATION SYSTEMS DESIGN CRITERIA**

Breakpoint Chlorination

Maximum Chlorine Dosage	30 mg/l
Average Chlorine Usage	550 lbs/day
Maximum Chlorine Usage	750 lbs/day
pH Control	
Maximum Sodium Hydroxide Dosage	1.7 lbs/lb of chlorine
Average Sodium Hydroxide Usage	940 lbs/day
Maximum Sodium Hydroxide Usage	1,330 lbs/day
Breakpoint Basin Volume	2,600 ft ³

Disinfection

Maximum Chlorine Dosage	5-8 mg/l
Average Chlorine Usage	165 lbs/day
Maximum Chlorine Usage	220 lbs/day
Contact Basin Volume	14,000 ft ³
Detention Times	
At Average Flow of 2.44 mgd	60 min.
At Peak Flow of 3.3 mgd	45 min.

Dechlorination

Sulphur Dioxide	
Maximum Dosage	15 mg/l
Average Usage	305 lbs/day
Maximum Usage	415 lbs/day
Dechlorination Basin Volume	3,200 ft ³
Detention Times	
At Average Flow of 2.44 mgd	15 min.
At Peak Flow of 3.3 mgd	10 min.

REAERATION SYSTEM

The effluent dissolved oxygen level would be increased in a reaeration basin with a detention time of approximately 90 minutes at average flow, as shown in Table 6.4. The pH of the final effluent would be controlled by the addition of sodium hydroxide, if necessary. The effluent and the sodium hydroxide would be mixed in the reaeration basin, which would have three 30 horsepower mechanical aeration units. The treated effluent would finally be discharged through a closed conduit into Whitewood Creek.

Table 6.4

REAERATION BASIN DESIGN CRITERIA

pH Control	1.7 lbs NaOH/lb of chlorine
Reaeration Basin Volume	20,000 ft ³
Number of Surface Aerators	3
Horsepower of Surface Aerators	30
Detention Times	
At Average Flow of 2.44 mgd	90 min.
At Peak Flow of 3.3 mgd	65 min.

SLUDGE HANDLING AND DISPOSAL

Aerobic Sludge Digestion

Waste sludge from the secondary clarifiers would be pumped to two parallel aerobic digester basins. The design criteria for the digesters are presented in Table 6.5. Based on a 1% underflow solids concentration from the clarifiers, the aerobic digesters would have a 20-day detention time. The aerobic digesters would allow supernatant to be decanted from the solids, thereby increasing the solids content and sludge detention time.

Table 6.5

AEROBIC DIGESTERS DESIGN CRITERIA

Number	2
Volume	14,375 ft ³
Detention Time	20 days
Solids Under Aeration	1%

Sludge Thickening

To decrease the volume of sludge that must be disposed of in the tailings pond, an air flotation thickening system would be used with the design criteria shown on Table 6.6. The sludge should be thickened from the 1% found in the aerobic digesters to 4% or 5% dry solids in the float cake.

To assist in the dewatering of the sludge, facilities for storing, mixing and adding polyelectrolytes would be provided inhouse in the air flotation units. A total of 4 to 5 pounds per day or 0.8 tons per year would be required.

Table 6.6

AIR FLOTATION THICKENER DESIGN CRITERIA

Number (1 standby)	2
Volume	600 ft ³
Dimensions	10 ft x 6 ft x 10 ft
Sidewater Depth	10 ft
Detention Time	3 hours
Air to Solids Ratio	0.02 lbs air/lbs solids
Solids Loading	15 lbs/day/ft ²
Polyelectrolytes Added	10 lbs/ton dry solids
Effluent Recycle Rate	100%

OPERATING FEATURES

Administration and Laboratory Building

An administration and laboratory building would house a laboratory with automatic sewage sampling equipment, sample storage, office space, lockers and restrooms, maintenance equipment, a storage area, plant instrumentation and monitoring equipment, and a small workshop area.

Electrical System

Electrical power for the treatment plant can be obtained from Black Hills Power and Light, who serves the site. Points of service would be established near the raw sewage pump station. As indicated above, all of the buildings housing pumping equipment would have standby generation equipment of sufficient capacity to maintain limited operation of the plant during power outages. During power outages, only the secondary treatment with effluent chlorination would be maintained.

Flood Protection

The proposed treatment plant location is adjacent to Whitewood Creek. The site would require some flood protection. Flood records for Whitewood Creek are very poor. However, discussions with local residents indicated that a recent flood produced a high water mark on a wigwam burner approximately 1 foot above the ground. The local residents also felt that this was the worst flood in memory, and some felt it was a 100-year frequency flood. Elevation for the site was set above this high water mark--at 4,440 feet above sea level. Protecting the site from the high water level would require 55,000 cubic yards of fill material from an offsite borrow area. The location of the offsite borrow area has not been defined. Prior to final design, a more detailed evaluation must be completed to confirm the flood protection elevation.

Location of a plant at the lower Deadwood site would require the relocation of an adjacent small creek. This creek would be relocated by channelization to the south side of the treatment plant discharge point (into Whitewood Creek) at the southeast corner of the proposed treatment plant.

LOWER DEADWOOD SECONDARY TREATMENT SYSTEM--I-E(3)

In the Lower Deadwood Secondary Treatment System--I-E(3), the District's wastes would be treated in a secondary treatment plant in lower Deadwood (Figure 6.1). Facilities in the secondary treatment plant, shown on Figure 6.3, would be similar to those described above for the AWT plant up through the secondary processes plus the effluent disinfection unit. Alternative I-E(3) would not provide any tertiary treatment. The following unit processes, described in the previous section, would be exactly the same for the secondary treatment system:

- Raw Sewage Pump Station
- Vertical Screens
- Pump Station No. 2
- Activated Biological Filter System
- Secondary Clarifiers
- Effluent Disinfection
- Aerobic Sludge Digestion
- Sludge Thickening

Unit processes not included in this alternative are listed below.

- Surge Pond
- Pump Station No. 3
- Mixed Media Filters

- Filter Backwash Storage Tank
- Filter Backwash Treatment Pond
- Breakpoint Chlorination
- Dechlorination
- Reaeration

Some minor changes in the sizing of various components could be considered because the secondary system would not have as many recycles as the AWT system. Because the treatment plant for the District has been sized for a stable population and the amount of expected recycle in the AWT system would be small, no change in equipment size should be contemplated at this time. Using AWT design criteria would allow the secondary treatment plant to be upgraded by a simple addition of other unit processes.

GRIZZLY GULCH LAND-BASED TREATMENT SYSTEM--III-E(1)

A land-based system located in the Grizzly Gulch area would be used to treat the combined industrial and municipal flows. The land-based treatment facilities would include a tailings dam, tailings-wastewater storage reservoir, transmission pipeline, and distribution and irrigation systems, as described below and shown on Figures 6.4 and 6.5. The District's wastewater would be delivered above the tailings dam. HMC's tailings would be delivered through a separate pipeline and would also be deposited above the dam. During the winter the combined wastewater would be stored in the tailings-wastewater storage reservoir. During the summer the wastewater would be pumped to an irrigation site above the reservoir, between Yellow and Whitewood Creeks. A sprinkler irrigation system would distribute the wastewater over the irrigation area. As the wastewater moves through the vegetation and the soil and rock profile, it would be treated by filtration, oxidation, crop uptake, adsorption, precipitation, denitrification and ion exchange.

TAILINGS DAM AND STORAGE RESERVOIR

A combined tailings-wastewater storage dam would be located in Grizzly Gulch, about 1,000 feet upstream from Airshaft No. 5. The dam would be rockfill with an upstream-sloping impervious core section. The upstream-sloping core offers the optimum in stability and safety for rockfill dams. The core material would be constructed of dewatered tailings and bentonite at optimum moisture for compaction. Filter material processed from sand tailings would protect both sides of the impervious core. According to HMC estimates, the waste rockpile (waste rock from mine excavation) would have sufficient rock volume for the dam embankment shell.

The reservoir would be designed to store (1) the estimated 1-in-10 year wet weather flow (through the winter storage period), (2) watershed runoff into the reservoir for the 24-hour duration, 100-year recurrence interval storms, and (3) tailings. A total storage of 3,130 acre-feet is required for combined wastewater and runoff storage and 590 acre-feet/year for tailings storage. The total required tailings-wastewater storage volume is thus 3,720 acre-feet for the first year and 14,930 acre-feet for the 20th year. This increase is due to the accumulation of tailings in the storage reservoir.

The initial dam structure would be 230 feet high (crest elevation 5,340 feet) and would be raised in lifts of 20 feet constructed approximately every 3 years. An emergency side channel spillway at the dam abutment would be provided at an elevation and capacity to protect the dam structure from overtopping. It would be sized to pass the Probable Maximum Flood from the watershed with a full reservoir at the beginning of the Probable Maximum Precipitation. Overflow would be diverted around the reservoir and into Grizzly Gulch. The spillway and spillway crest would be raised each time the dam is raised.

TRANSMISSION PIPELINE

Two pump stations would deliver water from the storage reservoir to the transmission pipeline. The pump stations would lift the wastewater from the storage reservoir to the irrigation site and provide pressure for irrigation. Because of the wide annual fluctuations in water surface elevations (120 feet initially and 20 feet after 20 years) and the increased reservoir surface elevation with time (140 feet in 20 years), Pump Station No. 1 would float on the reservoir. A total of about 1,300 horsepower is required in station 1 to lift the design volumes 400 feet (maximum) to station 2. The horsepower requirement would decrease with time as the water level increases and the lift decreases.

The estimated design peak flow for both pump stations and the pipeline is 18.7 cfs (12.1 mgd). A flexible line would be required between stations 1 and 2, as shown on Figure 6.5. Pump Station No. 2, at 5,600 feet elevation, would have about 1,600 horsepower and a total dynamic head of about 550 feet. A buried pipeline about 14,000 feet long would transport water from station 2 to the irrigation site. The total irrigation site would be about 1,900 acres with 1,520 acres irrigated. The remaining area would consist of required buffer strips, roads and areas unusable because of rocky conditions or slopes greater than 30%.

DISTRIBUTION SYSTEM

A buried distribution system would connect to the transmission pipeline to distribute water to the irrigation laterals. The distribution submains would be sized for about 7 gpm/acre for the irrigated portion, which would be served by the line with a minimum capacity of 800 gpm. A network of roads would follow the transport and distribution pipelines to provide access for operation and maintenance.

Remote-actuated electric valves would regulate flow to each of the irrigation laterals. Central control and monitoring would assure efficient irrigation control. Controls for the automated system would be housed in a control structure on the site. Remote readouts would monitor the operation of the pumping stations on a continuous basis.

The control building would also house a laboratory, administrative offices and maintenance facilities. The equipment required for automation and control of the irrigation system is expensive, but would result in overall savings because of reduced operation and maintenance costs.

IRRIGATION SYSTEM

An above-ground solid set system with rotating impact (agricultural) sprinklers would apply water to the irrigated land. To improve the uniformity of distribution, every other lateral would be offset so that the sprinklers would be arranged in a triangle. Maximum lateral length would be about 1,500 feet. Regular checking of the irrigation system would be required to detect plugged sprinklers and leaks.

Detailed field investigations have not been made on the proposed land application site, but soil conditions similar to those in Grizzly Gulch are assumed. Permeabilities of the clay layer measured in Grizzly Gulch varied over a wide range. Based on the average measured permeability and 1-in-10 wet year hydrology data, an effluent loading rate of 3 acre-feet per acre per season was established. With a 1-in-10 wet year precipitation of about 36 inches, the total hydraulic load on the land application site would be 72 inches (6 feet). During a year of average precipitation, a higher effluent loading rate could be used.

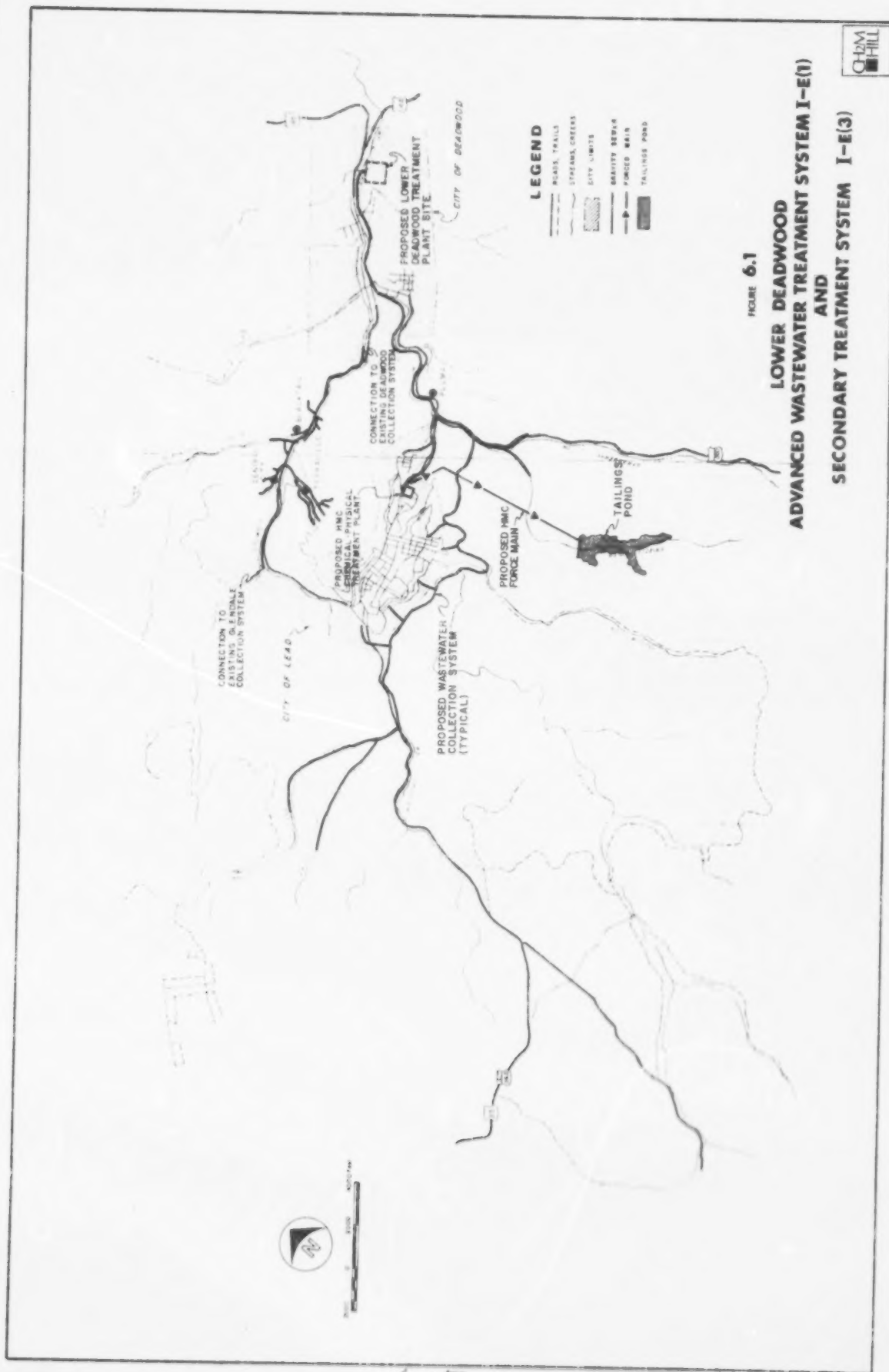
It is not known if an impermeable clay layer occurs in the proposed site or if the permeabilities measured in Grizzly Gulch are representative of the proposed site. Considerable field investigation of the soil would be required to assure the technical feasibility of vertical movement of the loading through the impermeable clay soil.

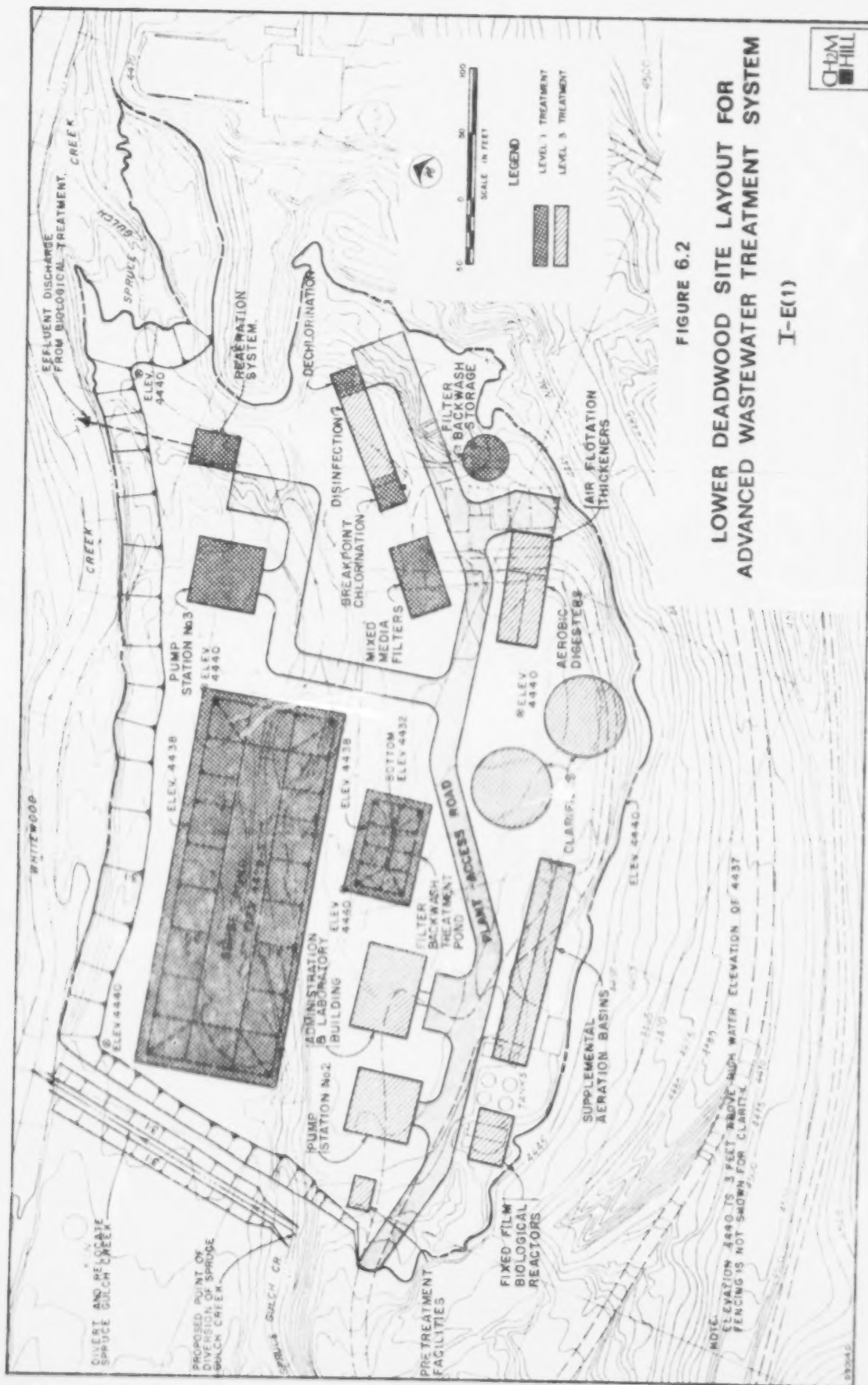
SUBSURFACE DRAINAGE

No subsurface drainage system is planned for the proposed site. An analysis of the ground water drainage capacity indicated that the proposed loadings on the site should not result in widespread drainage problems. However, no field investigations have been made of soil or rock permeability. A subsurface field investigation must be conducted to verify that drainage would not be required if the land-based alternative is considered further.

EFFLUENT DISPERSION

The applied effluent would percolate through the soil and geologic materials to the ground water. Once it reaches the ground water, it would move downslope to a point where the ground water intersects the surface in the drainage courses. Here the ground water outcrops as springs and seeps. An estimated 30% of the effluent would be lost to evapotranspiration on the site and in adjacent drainages; the remaining 70% would return to Whitewood and Yellow Creeks. No surface runoff of applied effluent would occur. Possible contamination of one or two privately owned domestic wells in the immediate area should be further investigated.





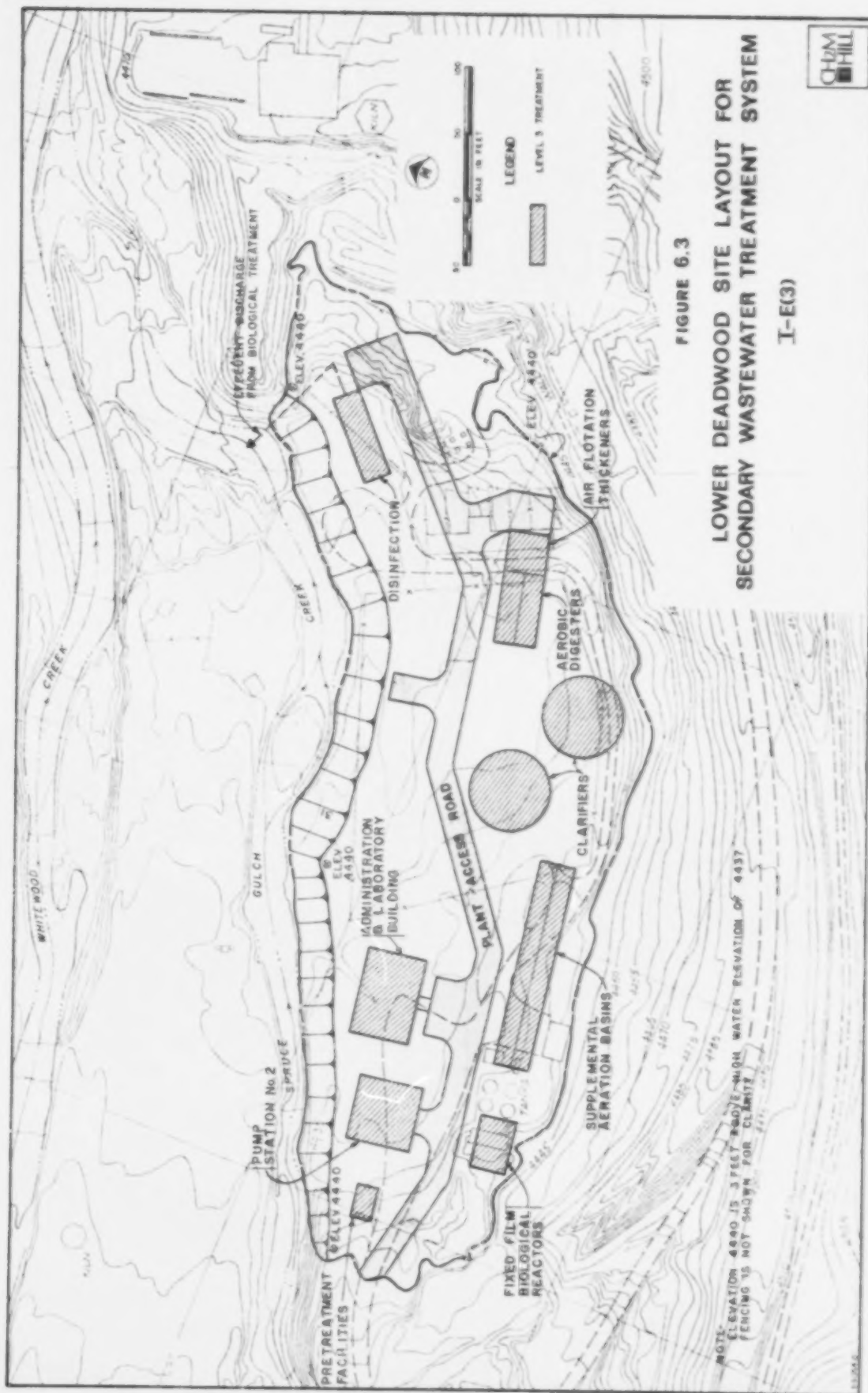
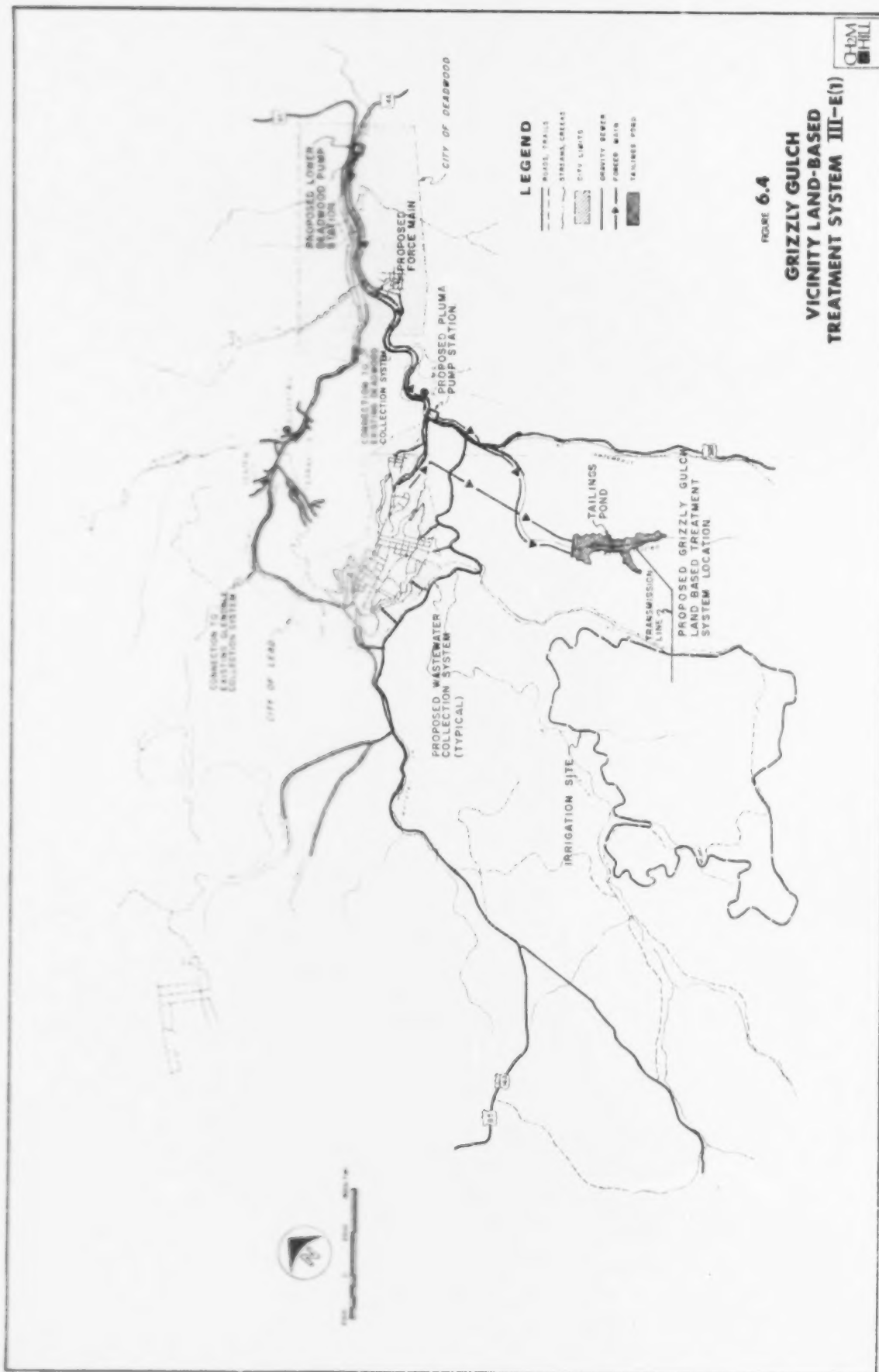


FIGURE 6.3

LOWER DEADWOOD SITE LAYOUT FOR
SECONDARY WASTEWATER TREATMENT SYSTEM

I-E(3)



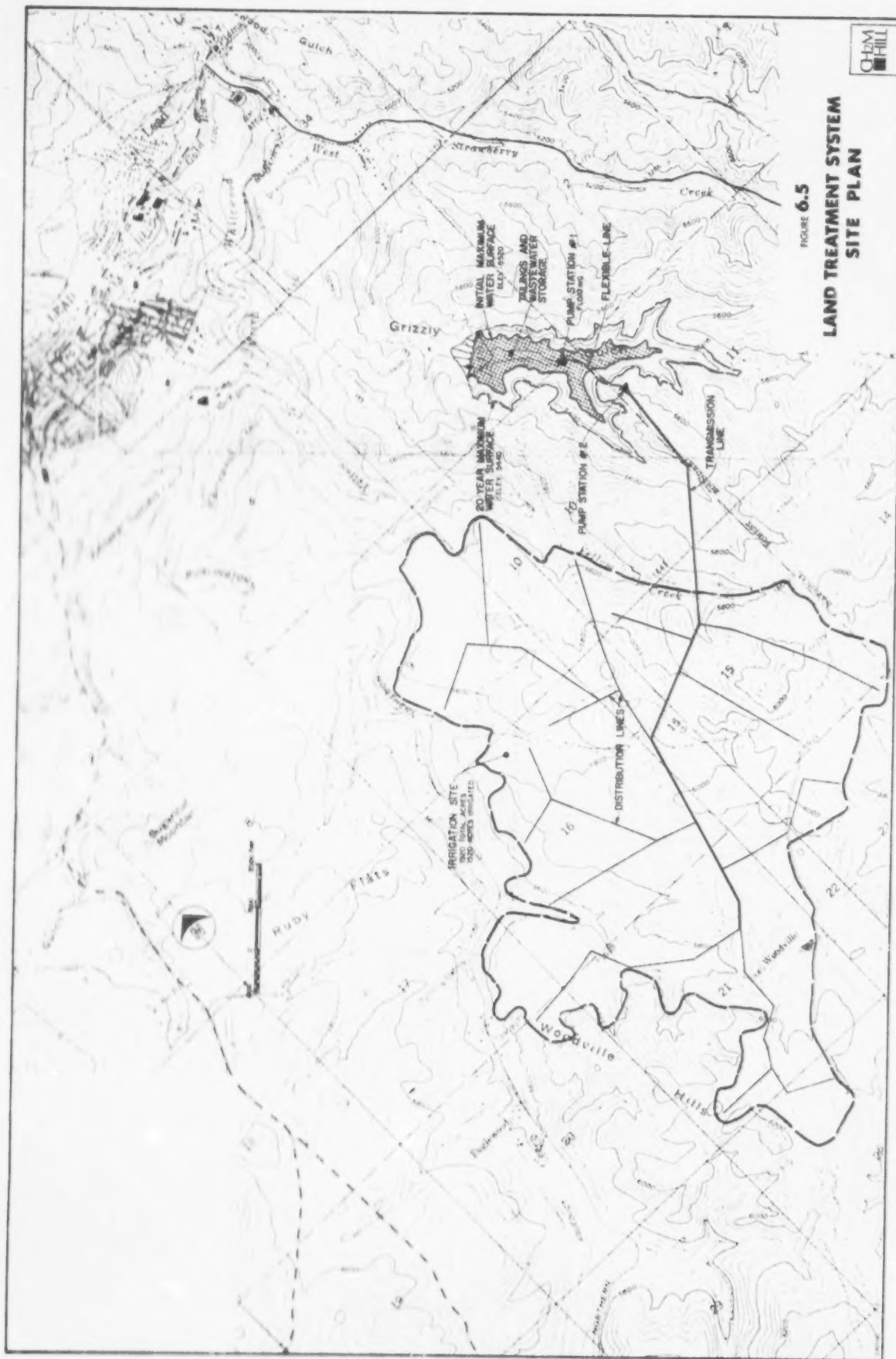


FIGURE 6.5
LAND TREATMENT SYSTEM
SITE PLAN



Chapter 7 ALTERNATIVE EVALUATION

Traditionally, public systems have been evaluated solely on the basis of monetary costs. However, other factors in addition to dollar costs must be evaluated prior to final plan selection and project funding. These other factors include environmental changes and social costs that often accompany the implementation of these systems.

This chapter addresses the major engineering and environmental considerations associated with the construction and operation of the three wastewater management alternatives selected for competitive evaluation. In addition, the impact of the no action alternative is evaluated to provide a benchmark from which to better assess the impact of each of the proposed actions. The comparative evaluation is summarized in Tables 7.1 and 7.2 at the end of this report.

This evaluation was made with the understanding that regardless of the alternative implemented, HMC would impound their wastes in a tailings pond at Grizzly Gulch and treat the decant water either at a physical-chemical plant at Lead or through a land-based system, probably at Grizzly Gulch. Furthermore, it was assumed that both the District and HMC would treat their wastewater to the level necessary to comply with applicable stream standards. Should either assumption be false, this comparative analysis would be invalid.

On the extreme right hand side of Tables 7.1 and 7.2, the alternatives have been ranked from most preferable to least preferable for each parameter. This ranking was determined by balancing the undesirable construction and operational effects against the long-term benefits of each system.

ENGINEERING CONSIDERATIONS

An evaluation of engineering factors should indicate the performance capabilities and costs associated with each of the wastewater management alternatives under consideration. The following engineering parameters were evaluated for each of the wastewater management alternatives:

- Project cost--the cost of the project in terms of total project cost, grant requirements, local cost, capital recovery, annual operation and maintenance cost, total annual cost, estimated District monthly

household cost, and present worth. Costs for both the District and HMC were calculated, as well as total costs.

- Effluent quality--the effluent quality expected from the wastewater management alternative, as well as the ability of the alternative to achieve the established water quality objective.
- Reliability--the alternative's ability to consistently produce the desired effluent quality.
- Flexibility--the alternative's ability to be expanded to increase plant capacity and upgrade treatment.
- Resource/chemical commitment--the amount of resources and chemicals required to operate the system.
- Land requirements--the amount of land required.
- Implementation--the alternative's preliminary implementation schedule, outlining the various tasks and the time believed necessary for their completion.

For the cost parameters, the alternatives were ranked from the District's point of view. The ranking therefore indicates the systems most favorable to the District. Ranking the alternatives by some other criterion, such as systems most favorable to HMC or systems with the lowest total cost, could dictate another order and modify the analysis.

PROJECT COST

Lower Deadwood AWT System--I-E(1)

As shown in Table 7.1 at the end of this report, the Lower Deadwood AWT System has the second lowest project cost and capital recovery and the highest operation and maintenance cost. The project cost and capital cost are lower for this system than for the Grizzly Gulch Land-based Treatment System--III-E(1). The total annual cost of the Lower Deadwood AWT System--I-E(1) is the highest of the three systems considered, while the present worth is the second highest.

Lower Deadwood Secondary Treatment System--I-E(3)

The Lower Deadwood Secondary Treatment System has the lowest project cost, capital recovery, and operation and maintenance cost, resulting in the lowest total annual cost. The present worth of this system is also the lowest of the three systems under consideration.

Grizzly Gulch Land-based Treatment System--III-E(1)

The land-based treatment system has the highest project cost and capital recovery and the second highest operation and maintenance cost. As a result, the system entails the second highest level of annual cost. This land-based treatment system has the lowest annual cost of any of the systems capable of achieving the water quality objectives. The present worth of this system is the highest of the three systems under consideration.

No Action Alternative--IV

The social and monetary costs of a continued lack of sewage treatment in the District are thought to be high but cannot be estimated at this time. Socioeconomic impacts of the no action alternative are discussed in the environmental impact comparison.

EFFLUENT QUALITY

Lower Deadwood AWT System--I-E(1)

The effluent quality that this system is designed to produce is shown in Table 7.1 and could satisfy the NPDES Discharge Permit. The Lower Deadwood Advanced Wastewater Treatment System might allow the development of a cold water fishery in Whitewood Creek. However, several of the effluent limitations required to meet the water quality objectives of Level 1 treatment might not be achieved. A discussion of those parameters for which potential problems exist follows. Also, the AWT plant would produce large quantities of sludge that would require handling and disposal.

Dissolved Oxygen. Although there is no effluent dissolved oxygen limitations given in the NPDES Discharge Permit (Table 2.1), the South Dakota Surface Water Quality Standards (Table 2.4) do specify a 7 mg/l value during the spawning season. Because Whitewood Creek flows would be very low in dry weather, it should be noted that the 7 mg/l dissolved oxygen standard (during spawning season) might not be achieved. At an elevation between 4,500 and 5,200 feet above sea level, the saturation value of oxygen in water at 20°C is approximately 7.7 mg/l. If alpha, the oxygen transfer coefficient of the wastewater, and beta, the oxygen saturation coefficient of the wastewater, are 0.9, the net driving force at 20°C is not large enough to produce an effluent with 7 mg/l dissolved oxygen content. As the water temperature drops, the saturation value of oxygen in water will increase, resulting in a larger net driving force. The 7 mg/l dissolved oxygen standard could then be met.

Total Residual Chlorine. In the biological treatment system, chlorine would be used for the oxidation of ammonia and for effluent disinfection. Although a dechlorination step is planned, the ability of this process to meet the 0.02 mg/l total chlorine residual is questionable and cannot be estimated until the exact makeup of the dechlorination process is known and pilot plant information is available.

Chlorides. Although there is no effluent chloride limitation given in the NPDES Discharge Permit (Table 2.1), the South Dakota Surface Water Quality Standards (Table 2.4) do specify a 100 mg/l limit for the stream. Because Whitewood Creek dry weather flow is small, the effluent chloride concentration needs to be examined. A standard of 100 mg/l of chlorides could be met if substantial quantities of chlorine are not added for ammonia oxidation and disinfection. Failure of the biological ammonia oxidation process would result in an increase in chlorine demand to achieve the ammonia standard. The net results of this operating procedure would be a drastic increase in the amount of chlorides in the wastewater effluent.

The raw wastewater must have a chloride level below 100 mg/l since chloride would not be removed by the treatment process. A combination of a moderately high raw wastewater chloride level and chlorides added by the treatment process could result in an effluent chloride level above the 100 mg/l standard.

Ammonia-Nitrogen. The ammonia-nitrogen standard of 0.6 mg/l could be achieved with the processes outlined for the biological advanced wastewater treatment system. A majority of the ammonia would be oxidized to nitrate in the fixed-film bioreactors and aeration chambers. This process may be able to achieve the standards during warm periods in the summer but is prone to reduced efficiencies in cold weather. Additional ammonia would be removed by breakpoint chlorination. This treatment should be able to meet the effluent requirement. The breakpoint chlorination system can absorb a great deal of the efficiency variations of biological treatment processes. However, complete failure of the biological process would result in a discharge of ammonia and chloramines.

Nitrate. Although there is no effluent nitrate limitation given in the NPDES Discharge Permit (Table 2.1), the South Dakota State Surface Water Quality Standards (Table 2.4) do specify a 50 mg/l limit for the stream. Because Whitewood Creek dry weather flow is small, the effluent nitrate concentration needs to be examined. The nitrate standard of 50 mg/l could be exceeded if more than 12 mg/l of ammonia-nitrogen is oxidized in the biological process. To meet the 50 mg/l nitrate standard, the ammonia removal of the biological

nitrification process must be limited and the remaining ammonia must be removed by breakpoint chlorination, requiring precise operation of the treatment system. A substantial increase in chlorine requirements would also result. To meet the nitrate standards, an additional unit process (denitrification or some other form of nitrogen removal) must be included in the treatment system. Inclusion of this treatment process would substantially increase the construction and operating costs.

Heavy Metals. The biological advanced wastewater treatment system would not be specifically designed to remove heavy metals. Some limited heavy metal removal could be achieved by this system. The ability of this system to remove heavy metals would strictly be a function of the influent heavy metal concentrations. If the influent contains substantial quantities of heavy metals, this treatment system would not meet many of the heavy metal standards.

Total Cyanide and Free Cyanide. This advanced wastewater treatment system is not designed to remove cyanide, although some may be removed. The amount of cyanide removal expected in a biological treatment plant must be determined by actual operating data or a pilot plant study. If cyanide is present and the wastewater is exposed to chlorine, cyanogen chloride may be formed. Cyanogen chloride has been identified by the EPA as a potentially dangerous toxicant that could prevent the establishment of a cold water fishery in the area streams.

Undisassociated Hydrogen Sulfide. The ability of the advanced biological wastewater treatment system to meet the extremely low 0.002 mg/l standard is unknown.

Lower Deadwood Secondary Treatment System--I-E(3)

The secondary treatment plant defined for this alternative should produce an effluent that would comply with the Federal definition of secondary treatment. This system's effluent would not satisfy the present NPDES Discharge Permit effluent limitations or the cold water fishery water quality objectives of the State of South Dakota.

Effluent produced by this system probably would not allow the establishment of a cold water fishery in Whitewood Creek.

Some sludge requiring further management would be produced by the secondary treatment system.

Grizzly Gulch Land-based Treatment System--III-E(1)

The effluent produced by the land-based treatment system is believed to have the best chance of establishing a cold water fishery in Whitewood Creek. It is also believed to have the highest quality attainable among the three systems under consideration. The land-based treatment should be able to meet most of the required effluent limitations. The fate of cyanide within the treatment process is presently unknown and would have to be determined by pilot plant study. Most of the heavy metals could be removed to the level called for in the NPDES Discharge Permit in a properly designed and operated system. If anaerobic soil conditions are allowed to develop, some of the heavy metals may become soluble and hydrogen sulfide may be generated, resulting in a level over the respective standards. The ability of this system to achieve and maintain the water quality standards for dissolved oxygen is presently unknown. The expected discharges from the land-based treatment system would be spread over a wide area and their effects on the dissolved oxygen level in the streams cannot be estimated at this point.

This land-based system would only produce a minimal amount of sludge.

RELIABILITY

All of the wastewater management alternatives would use flow reduction Alternative E in the City of Lead, which calls for the construction of a bypass structure near the present HMC mill. This structure would be designed to bypass flows over a predetermined value to Gold Run Creek and thus Whitewood Creek. All alternatives would bypass storm and domestic wastes from Lead's combined sewer system during intense rain storms. Thus, during storms none of the alternatives would fulfill the reliability criterion of consistently producing the desired effluent.

Lower Deadwood AWT System--I-E(1)

The AWT system considered in this alternative involves a large number of different unit processes. The effectiveness of the treatment system is thus dependent upon satisfactory operation of all of these unit processes. Several of the unit processes have the ability to absorb some minor variation in performance by upstream processes, although the treatment plant is not designed to provide redundancy in case of a failure of any given unit process. With proper operation, plant upsets should be relatively uncommon and the system should be able to consistently produce the designed effluent.

Because the hydraulic detention time of the waste is short when compared to time for the land-based treatment system, plant upsets would be readily detectable and modifications to bring the treatment plant back into compliance could be instituted fairly quickly. The ability of the treatment system to perform satisfactorily and absorb shock loads is not as great as for the land-based treatment system, although its ability to recover from shock loads that affect effluent quality is greater.

The operation and maintenance of an AWT plant requires highly skilled and technically competent operators. Small districts and towns historically have had problems operating and maintaining a complex treatment system.

Lower Deadwood Secondary Treatment System--I-E(3)

The reliability of the secondary treatment system is similar to that of the AWT system discussed above. Because this system involves fewer unit processes, the degree of complexity is much less, resulting in greater operational reliability.

Grizzly Gulch Land-based Treatment System--III-E(1)

The land-based treatment system offers the greatest degree of reliability because it involves fewer separate unit processes. Properly designed and operated, this system should produce the designed effluent limitations more consistently than would either of the other alternatives.

The storage pond required by this system offers a great deal of buffering capability, which would minimize the effects of shock loadings or toxic waste.

Failure to meet the effluent limitations resulting from improper operation would require a long time to detect due to the long hydraulic detention time associated with the storage pond and the irrigation system. The time required to bring the treatment system back into compliance would also be extensive due to the hydraulic detention time of the system. Improper operation or application of the wastewater could affect effluent quality of the system for several years to come, whereas modifications to the treatment process in the other alternatives are relatively short term.

FLEXIBILITY

Lower Deadwood AWT System--I-E(1)

The AWT system considered for lower Deadwood can be readily expanded to increase plant capacity by the addition of parallel

unit processes. The treatment system can also be easily modified to produce a higher quality effluent by the addition of more unit processes.

Due to site restrictions, a large expansion of the treatment plant could conflict with the present rodeo grounds parking lot.

Lower Deadwood Secondary Treatment System--I-E(3)

The secondary treatment system in lower Deadwood offers the greatest flexibility in terms of expansion and treatment upgrading. Additional unit processes could be added to this treatment to bring the effluent into compliance with the present NPDES Discharge Permit. Expansion of the treatment plant's capacity can be readily accomplished and would not present a serious conflict with the rodeo grounds parking lot.

The flexibility offered by this treatment system would allow a phasing or step approach in the development of a treatment system capable of producing the effluent limitations required in the present NPDES Discharge Permit. The construction of this treatment system could represent a first step in the development of an areawide wastewater management program. Additional time would be available to investigate the uncertainties about determining effluent limitations that would actually allow the establishment of a cold water fishery in Whitewood Creek.

Grizzly Gulch Land-based Treatment System--III-E(1)

Expansion of this system to upgrade effluent quality and increase system capacity would be difficult and would require an expansion of the storage pond and additional land areas for irrigation. However, it is believed that this treatment system would satisfy the zero pollution requirements of Public Law 92-500 without the addition of more unit processes.

RESOURCE/CHEMICAL COMMITMENT

Lower Deadwood AWT System--I-E(1)

This alternative would require about 3,700,000 kWh/year for operation, of which the AWT plant at lower Deadwood would consume the largest proportion--3,100,000 kWh/year. The separate HMC operation would require 600,000 kWh/year. Chemical commitments are the largest for this alternative due to the operation of the AWT plant located at lower Deadwood.

Lower Deadwood Secondary Treatment System--I-E(3)

Total annual power required for this alternative would be 3,000,000 kWh/year. A secondary treatment plant at lower Deadwood would consume 700,000 kWh/year less than would the AWT plant. HMC's power consumption would be 600,000 kWh/year, the same as required for the Lower Deadwood AWT Treatment System--I-E(1).

This system has the second highest annual use of chemicals.

Grizzly Gulch Land-based Treatment System--III-E(1)

Although this system would have the lowest chemical usage, it would require the most power for operation--8,300,000 kWh/year. The high power usage can be attributed to the pump stations.

LAND REQUIREMENTS

Lower Deadwood AWT System--I-E(1)

The AWT plant at lower Deadwood would require a 6.0-acre site. The HMC tailings pond at Grizzly Gulch would ultimately require 200 acres. Should HMC decide to develop a separate land-based treatment system (rather than a physical-chemical treatment plant at Lead), additional land would be needed.

Lower Deadwood Secondary Treatment System--I-E(3)

The land requirements for this alternative are nearly the same as those for the Lower Deadwood AWT System--I-E(1). The only difference is that the secondary treatment plant would require a 3.5- rather than a 6.0-acre site.

Grizzly Gulch Land-based Treatment System--III-E(1)

This alternative is the most land intensive--200 acres would be needed for a tailings-wastewater storage pond and 1,900 acres would be required for the effluent application site. Land ownership of the site area for this alternative is given on Figure 7.1.

IMPLEMENTATION

Lower Deadwood AWT System--I-E(1)

This alternative could be designed, built and on line in early 1980. The major time-consuming elements include site acquisition, pilot plant study, plant design, and construction, as shown on Figure 7.2.

Lower Deadwood Secondary Treatment System--I-E(3)

Of the three alternatives, this system has the shortest implementation period, as shown on Figure 7.3. The plant could be on line in the autumn of 1979. This project would be relatively easy to implement because pilot study would not be necessary and plant design would not be as complex as for the AWT plant.

Grizzly Gulch Land-based Treatment System--III-E(1)

This project could not be on line until the fall of 1980, as shown on Figure 7.4. Its implementation would take longer because of land acquisition difficulties, the need for a complex and detailed environmental assessment, and a complex design requiring pilot study.

ENVIRONMENTAL IMPACT COMPARISON

The implementation of any of the three alternatives would result in both negative and positive environmental changes. In the following evaluation, negative construction effects are discussed first and then compared to the environmental advantages and disadvantages of project operation. The two separate treatment systems, Lower Deadwood AWT--I-E(1) and Lower Deadwood Secondary Treatment--I-E(3), are analyzed together because the impacts accompanying their implementation are similar. The combined Grizzly Gulch Land-based Treatment System--III-E(1) and the impact of the no action alternative, IV, are presented separately.

An impact analysis of the proposed wastewater collection system is not included in this chapter because the collection system for each of the three candidate treatment alternatives would be the same, with the exception of some minor differences. Consequently, inclusion of the collection system analysis would not contribute to a comparative evaluation of the proposed alternatives. However, the collection system has received detailed environmental discussion in the Task 11 report entitled "Definition of Treatment Requirements and Alternatives."

The outcome of this environmental analysis depends greatly on the actions implemented by HMC. If a separate treatment system is adopted, either the Lower Deadwood AWT--I-E(1) or Secondary Treatment--I-E(3) System, and HMC decides to build a land-based treatment system rather than a physical-chemical

treatment plant at Lead, the environmental impacts of the three alternatives would share more similarities than differences. Conversely, if HMC builds the physical-chemical treatment plant at Lead, the adverse environmental effects of either of the separate treatment alternatives, Lower Deadwood AWT--I-E(1) or Secondary Treatment--I-E(3), would be markedly less than for the combined domestic/industrial Grizzly Gulch Land-based Treatment System--III-E(1).

IMPACTS ON SOIL, GEOLOGY, AND AIR QUALITY

Lower Deadwood AWT--I-E(1) and Secondary--I-E(3) Systems

Construction of either of the treatment plants requires excavation and site preparation that would expose onsite soil to erosion and increase dust locally. Although the AWT system, I-E(1), requires more construction than the secondary system, I-E(3), the impacts would be similar.

Erosion impacts should be minimal because the affected area has nearly level topography. Dust impacts would be confined to lower Deadwood and may be bothersome during windy conditions. Dust can be controlled by proper construction procedures.

In addition, the plant site at lower Deadwood would require importation of fill material, 55,000 cubic yards for the advanced treatment plant and 27,000 cubic yards for the secondary treatment plant. Extraction of this material would obviously expose the borrow area to erosion and alter its topography. At present, the borrow area has not been established, so assessment of the related environmental impacts is not possible.

The development of a tailings pond by HMC would involve significant excavation and grading that would expose soil in the vicinity of Grizzly Gulch to erosion. Erection of the tailings dam would require importation of fill material because the dam would be built from HMC tailings and waste rock. The impact of the acquisition of the rockfill material is unknown.

Should HMC implement a separate land-based treatment system, which would result with implementation of either I-E(1) or I-E(3), impacts on soil and geology would be similar to those discussed below for the combined Grizzly Gulch Land-based Treatment System--III-E(1). However, the magnitude of impact would be less because a separate HMC system would require a smaller application site than would the combined land-based system, III-E(1).

The operation of either the lower Deadwood AWT or secondary treatment plant would not affect soil or geology, but might have a small effect on local air quality. Vehicular emissions would increase because workers would drive to the new plant and trucks would deliver supplies for operation. Because it would require more personnel and supplies for operation, the AWT plant would have the greater impact.

Air quality in the vicinity of Grizzly Gulch may be affected by dust from a separate HMC tailings pond. During pond draw-down (either by evaporation or during land application in summer), the periphery of the impoundment would be dry and tailings could be blown offsite during windy periods. However, HMC would probably be required to control this problem.

Grizzly Gulch Land-based Treatment System--III-E(1)

Development of the combined Grizzly Gulch Land-based Treatment System--III-E(1) would require earthwork for access roads, pump stations and pipeline installation. Because steep slopes would be traversed by heavy equipment during development, erosion and alteration of surficial geology in the project area would be expected. Local dust levels would also be increased by the construction activities.

Second, dam construction would require a large volume of imported rock and fill material. Because the dam required for this system would be built of rock, the volume of rock needed would be much greater than for either of the separate treatment systems, I-E(1) or I-E(3). The borrow area would either be in Grizzly Gulch or an outside area. Extraction of the fill material could cause an adverse impact, but the significance of this will remain unknown until a borrow area is determined. It is possible that waste rock from HMC could be used for dam construction, in which case adverse impacts would be avoided. Hauling the fill to the dam site would cause a slight short-term impairment of local air quality.

Last, pump stations would be built at lower Deadwood and Pluma. The impact of this is expected to be small and localized. The force main used to convey wastewater to the tailings-wastewater pond at Grizzly Gulch would be placed in the same trench as the proposed gravity interceptor, so additional erosion impacts would be minimal. Construction of the section of force main from Pluma to Grizzly Gulch would follow the shoulder of U.S. Route 385, causing possible short-term erosion.

The operation of maintenance vehicles would have a negligible impact on air quality. In contrast, the operation of the tailings pond could present a dust problem similar to that

mentioned previously for the separate HMC operation. The problem could be of greater magnitude with the combined land-based system because of the larger tailings-wastewater storage pond and greater pond drawdowns required.

The land-based system involves application of 3.0 feet of wastewater over a 165-day irrigation season; normal precipitation is 2.0 feet per year. The effects of this system on soil and geology are not fully known, but physical as well as chemical effects are expected.

The soil and surficial geology on the application site may be physically changed. Slopes on the site range from nearly level to up to 30°. About a third of the site has slopes ranging from 15 to 30°. The application of 3.0 feet of water (in addition to natural precipitation) to steep slopes could accelerate erosion. Second, much of the soil on the application area is thought to be underlain with clay. Application of additional water may cause soil movement and sloughing. Landslides of talus slopes may also occur.

The wastewater to be applied to the land would contain heavy metals. The fate of heavy metals applied to the soil is unknown. If the metals accumulate in the soil, toxic conditions could eventually develop.

The operational impacts of the combined Grizzly Gulch Land-based Treatment System are expected to be similar to, but of greater magnitude than, those for a possible separate HMC land-based treatment system because the combined system involves more wastewater and thus requires more land for treatment. In contrast, should HMC develop a separate physical-chemical plant in Lead under one of the separate treatment alternatives, these impacts would not occur.

No Action Alternative--IV

The decision to not provide sewage treatment in the Lead-Deadwood area would avoid the potential for erosion and dust impacts that would accompany the development of any of the three proposed alternatives.

Operational impacts, such as increased local vehicular emissions or soil erosion and sloughing, that could be caused by either a combined or separate land-based treatment would also be avoided.

WATER QUALITY

Lower Deadwood AWT--I-E(1) and Secondary--I-E(3) Systems

Construction of either I-E(1) or I-E(3) would be adjacent to Whitewood Creek, so it is possible that spoil material would be inadvertently pushed into the stream channel. Due to the present high volume of tailings in the creek, possible additions of sediment are not expected to be further injurious to water quality.

Construction of the lower Deadwood AWT plant would require the rerouting of a small creek running through the proposed plant site. Development of the lower Deadwood secondary treatment plant under I-E(3) would encroach on but not require rerouting of this creek.

Construction of separate HMC treatment processes--a tailings pond and possible land application site--would greatly increase turbidity in Grizzly Creek. This sediment-laden water would then be carried to the upper, relatively pollution-free reach of Whitewood Creek above Pluma.

Water quality in Gold Run and Whitewood Creeks is severely impaired by industrial and raw domestic waste discharges. No viable aquatic organisms are found in Gold Run and Whitewood Creeks from the point of Lead's combined sewer discharge to the Belle Fourche River, some 60 miles downstream. The implementation of either alternative would greatly benefit water quality by eliminating the untreated wastewater discharges. However, the magnitude of local water quality impact varies between the two systems.

Properly managed, the Lower Deadwood AWT System--I-E(1) should fulfill water quality standards for Whitewood Creek. Even though this system represents advanced wastewater treatment technology, it may not provide sufficient removal of residual chlorine, chlorides, ammonia-nitrogen and nitrate to fulfill existing stream standards. Also, if total cyanide, free cyanide, or heavy metals occur in the raw domestic waste, stream standards may be violated.

The lower Deadwood AWT plant is not designed to remove cyanide or heavy metals, although some removal is probable. The amount of cyanide removal must be determined by actual operating data or pilot study. If cyanide is present and the wastewater is exposed to chlorine, cyanogen chloride may be formed and possibly preclude the establishment of a cold water fishery. The capability of the system to fulfill heavy metal standards is dependent on heavy metal concentrations in the influent.

The Lower Deadwood Secondary Treatment System--I-E(3) would not fulfill existing water quality standards. Provision of secondary treatment (with separate industrial treatment of HMC wastes) would not be as beneficial to local water quality in Whitewood Creek as would the high level of wastewater treatment provided by both the Lower Deadwood AWT System--I-E(1) and the combined Grizzly Gulch Land-based Treatment System--III-E(1). But secondary treatment would afford a vast improvement over existing water quality conditions. Whitewood Creek would flow clear (versus leaden gray), and many forms of aquatic life could be reestablished. During low flow periods a reach of creek just below the secondary plant outfall may be uninhabitable for fishlife due to excessive concentrations of ammonia-nitrogen and residual chlorine.

Regionally, the Lower Deadwood Secondary Treatment System would benefit the water quality in the lower reaches of Whitewood Creek and the Belle Fourche and Cheyenne Rivers as much as the proposed Lower Deadwood AWT System would. As indicated earlier in this report, the most significant regional, as well as local, pollution source is tailings from HMC. The mine tailings would be removed irrespective of the alternative chosen. Additional treatment of domestic wastes (above secondary treatment) would benefit the reach of Whitewood Creek just below the plant outfall but would have little effect on regional water quality.

Grizzly Gulch Land-based Treatment System--III-E(1)

Construction of the access roads and effluent irrigation laterals on the land application site is anticipated to accelerate erosion. It is probable that sediment would be carried to the upper reaches of Yellow and Whitewood Creeks during storm runoff. In addition, construction of the effluent transmission line from the tailings pond to the application site would cross Yellow Creek, causing a temporary upset of the ecology in that immediate reach of stream.

In order of magnitude, construction of this combined land-based system is expected to have greater adverse impacts on water quality (principally due to runoff and siltation) than is development of a separate HMC tailings pond and possible land-based treatment system. A separate HMC project would affect Grizzly and possibly Whitewood Creeks. Conversely, construction of the application site for the combined Grizzly Gulch Land-based Treatment System--III-E(1) would affect the Grizzly, Yellow and Whitewood Creeks drainages.

In contrast to its adverse construction impacts on water quality, the Grizzly Gulch Land-based Treatment System--III-E(1) has the best possibility of meeting existing stream

standards because it would produce a slightly more reliable effluent than would the Lower Deadwood AWT System--I-E(1). However, possible problems do exist. The fate of cyanide and chlorides is presently undocumented and would not be known until after completion of a pilot study. Second, should soil on the application site become anaerobic, certain heavy metals may become soluble. These could be carried to the creeks and exceed existing stream standards. The unknown impacts of cyanide and chlorides and the long period of time for their detection are some of the principal operation disadvantages of this alternative.

No Action Alternative--IV

Maintenance of existing practices would result in continued degradation of Gold Run, Whitetail, Deadwood, and Whitewood Creeks, the Belle Fourche and Cheyenne Rivers, and Oahe Reservoir. Consequently, recently promulgated stream standards for Whitewood Creek and its tributaries would be violated.

HYDROLOGY

Lower Deadwood AWT--I-E(1) and Secondary--I-E(3) Systems

Water diversions by HMC, discharges of raw municipal sewage and natural inflow all affect the hydrology of Whitewood Creek. These factors increase the stream's average natural flow to about 15 cfs in the reaches through Deadwood. The creek is basically an influent stream--ground water travels to rather than away from the channel--so that flows increase to an average of about 25 cfs at the confluence with the Belle Fourche River 60 miles downstream.

Implementation of either the Lower Deadwood AWT--I-E(1) or Secondary Treatment System--I-E(3) would have an equal impact on streamflow in Whitewood Creek. As mentioned previously, HMC flow reduction measures would dewater the creek by about 6.0 cfs. Conveyance of Lead's domestic wastewater through a new interceptor would eliminate an additional 2.3 cfs from the reach of creek between Lead and Deadwood. Therefore, average flow in the creek would be reduced from 15 to 6.7 cfs in the reach between Lead and Deadwood. Below the treatment plant outfall in lower Deadwood under either treatment system I-E(1) or I-E(3), average flow would be about 9.0 cfs.

Grizzly Gulch Land-based Treatment System--III-E(1)

As in all the alternatives, HMC would implement flow reduction, which would reduce streamflow in Whitewood Creek by about 6.0 cfs. Second, 3.6 mgd (5.4 cfs) of Grizzly Gulch runoff and the Lead-Deadwood area wastes, which presently

enter Whitewood Creek, would be collected and placed in Grizzly Gulch for storage. An average of about 8.0 mgd (365/165 x 3.6) or about 12 cfs would be applied daily during a 165-day irrigation season. About 70% of the water applied would return to the water regime and 30% would be lost to evapotranspiration and the underlying geology. The time required for the water to reach the streams is not known, but it is expected that more water would flow to the streams during the summer application period.

Regardless of the yearly distribution, flows returning to the upper reaches of Whitewood and Yellow Creeks would subsidize the natural flow, because wastewater not usually occurring in these reaches is pumped from the Lead-Deadwood area to areas upstream. In contrast, flow in the lower reaches of Whitewood Creek, where it runs through the Lead-Deadwood area, would be reduced by the amount lost during land-based treatment from evapotranspiration (30%). On an annual average, flow in this portion of Whitewood Creek would be reduced by 1.6 cfs (5.4 cfs x .30). With this average loss (1.6 cfs) added to the loss resulting from HMC flow reduction practices (6.0 cfs), Whitewood Creek through Deadwood would lose about 7.6 cfs with the implementation of the Grizzly Gulch Land-based Treatment System--III-E(1).

VEGETATION AND WILDLIFE

Lower Deadwood AWT--I-E(1) and Secondary Treatment--I-E(3) Systems

The proposed lower Deadwood plant site, which would be used for either treatment plant, is currently an auto wrecking yard; no significant vegetation or wildlife is found there. Consequently, construction of either the lower Deadwood AWT or secondary treatment plant is not expected to adversely affect vegetation or wildlife.

Development of the HMC tailings pond would inundate 200 acres of productive wildlife habitat in Grizzly Gulch. Should HMC build a land-based treatment system in Grizzly Gulch, changes in vegetation and wildlife are anticipated (see "Grizzly Gulch Land-based Treatment--III-E(1)" below). In contrast, if HMC developed a physical-chemical treatment plant in Lead, the impacts associated with a separate land-based system would be avoided.

Although the degree of benefit differs, operation of either alternative would have a positive impact on the vegetation and wildlife of Whitewood Creek.

The principal benefit that the Lower Deadwood AWT System---I-E(1) offers over the Lower Deadwood Secondary Treatment System--I-E(3) is the possibility of a cold water fishery in Whitewood Creek. However, because the AWT process may not remove certain pollutants (see previous section entitled "Water Quality"), Whitewood Creek might not achieve cold water fishery status.

Implementation of the Lower Deadwood Secondary Treatment System--I-E(3) would result in a marked improvement over existing conditions--direct discharges of raw sewage to the creek would be eliminated--but would probably not permit a cold water fishery for some distance below the plant outfall. However, a trout fishery may be possible above the plant outfall, including the reaches of Whitewood Creek which pass through Deadwood, if HMC rectified their discharges.

It should be recognized that the production of high quality effluent may not, by itself, allow the rejuvenation of cold water fish in Whitewood Creek. Many persistent problems exist, including existing tailings deposits, storm runoff and low flow. The impact of these problems on the possibility of establishing a cold water fishery is not known.

Extant tailings deposits both in the stream channel and along the adjoining flood plain may continue to leach ~~heavy metals~~ such as cyanide and mercury. The effect of the tailings deposits and the length of time necessary for the creek to purge itself remain unknown.

Second, storm runoff, which would continue to flow directly into the creek without treatment, and bypasses of raw sewage and storm flows in Lead during heavy precipitation would affect water quality. Because old tailings are used during winter to sand city streets, storm flows may contain these tailings and their pollutants as well as other pollutants.

Last, flow reduction by HMC and the lessening of interbasin water diversions by 4.0 mgd would affect the biology of Whitewood Creek. It is unknown if the streamflow would be too low to support fishlife during dry years.

The implementation of either alternative would benefit terrestrial (land) wildlife. The establishment of aquatic life in the creek would augment the localized food chain and benefit such animals as raccoon, muskrat, waterfowl and shore birds which reside near water.

Even with the secondary treatment system, many forms of aquatic life could be reestablished in the creek and supplement the local food chain. Waterfowl, muskrat, beaver and raccoon,

etc., are not dependent on high quality water for survival. Moreover, the regional benefits to aquatic and semiaquatic wildlife would be similar for either alternative because, as mentioned previously, the major benefit to the regional ecology would result from the removal of HMC wastes.

Grizzly Gulch Land-based Treatment--III-E(1)

The application site for the land-based treatment system contains productive wildlife habitat and many species of game and nongame animals. About one-third of the site has been logged and presently supports grasses and scattered deciduous and coniferous seedlings; numerous old snags remain standing. Evidence of deer and wild turkey is abundant; woodpeckers and squirrels use the old snags for nests. The remaining two-thirds of the site is forested, with ponderosa pine, spruce and aspen the prevailing tree species. The ~~spore~~^{spoor} of many birds and mammals was found.

The construction of the major irrigation laterals and required access roads for the Grizzly Gulch Land-based Treatment System would cause an ecological disturbance over an area of about 2,000 acres. Heavy equipment would travel over rugged topography, removing vegetation and altering land forms. In many cases, it would be necessary to remove vegetation permanently. The removal of vegetation would have little effect on local wildlife, but the human intrusion and noise caused by the construction process would disturb the more timid species. Construction of the necessary pump stations at lower Deadwood and at Pluma would require removal of small amounts of vegetation; wildlife should not be affected.

To offset these negative construction impacts, operation of the Grizzly Gulch Land-based Treatment System would provide benefits to the Whitewood Creek animal and plant life similar to those previously discussed for the Lower Deadwood AWT System--I-E(1). Because the combined land-based system may produce a higher quality and more reliable effluent than would the lower Deadwood AWT plant, it could be slightly more beneficial.

The land-based system may have some localized operational impacts on vegetation and wildlife that also must be considered. Although the impact of applying 3.0 feet of water above natural precipitation to a semiarid ecosystem is hard to ascertain, some general observations can be made. It is anticipated that onsite vegetation would be affected by both the additional moisture and the chemical constituents in the wastewater.

(1) See "Evaluation of Land Application of Lead-Deadwood Wastewaters," May 14, 1975, in the Appendix.

The application of 3.0 feet of additional water is expected to replace the drier (destroyed forest and ponderosa pine forests) plant communities with mesic species. Increases of sedges, and possibly birch, alder, and willow, would be expected.

Second, the additional water may greatly stimulate the growth of herbs, shrubs and tree saplings on the decaying forest portion of the application site. Plants on the disturbed area are the ones most likely to benefit from water subsidies.

Last, the application of water could stimulate trees to produce shallow root structures, exposing them to damage by strong winds. Spruces are the most likely to be blown down because they are naturally shallow rooted.

According to available data, the wastewater constituents are expected to be in small enough concentrations to avoid serious damage to vegetation. However, the impact of the predicted concentrations of cyanide, zinc and arsenic on vegetation is uncertain.

The application of additional water to the forested site near Grizzly Gulch is expected to have slightly positive or neutral effects on wildlife. Pennsylvania State University has researched the effects on rabbits and deer of spray irrigation of effluent at the rate of 2 inches per week. Results of this study are quite favorable. It was found that whitetail deer used the application sites at least as readily as the untreated sites for feeding, and when test animals were averaged, a preference for the treated site was evident.⁽²⁾ In addition, rabbits residing on the treated site had a nutritional condition superior to the condition of those on the untreated site.⁽³⁾

Although the impacts appear positive, it must be pointed out that the effluent used in the Pennsylvania State University study was from domestic sources and may not have had the heavy metal constituents present in the HMC wastewater. Heavy metals could possibly be taken up in plant life and later consumed by foraging animals. As noted, the effect of these metals on the food chain in the vicinity of the project area is not known.

(2) Gene W. Wood, W. W. Simpson, and R. L. Dressler, Recycling Treated Municipal Wastewater and Sludge Through Forest and Cropland. "Effects of Spray Irrigation of Forests with Chlorinated Sewage Effluent on Deer and Rabbits," 1973, p. 319.

(3) Ibid., p. 320.

The operation of the irrigation process would require constant attention. This human activity could obviously be disruptive to some wildlife species. Because deer are relatively adaptive to man, they should not be adversely affected, but more timid wildlife such as wild turkeys would probably vacate the site during the irrigation season.

No Action Alternative--IV

The no action alternative would avert the construction impacts accompanying the three proposed alternatives. The most significant benefit of "doing nothing" would be avoiding the impact of building a tailings pond at Grizzly Gulch. This impact, which is assumed to be common to all three alternatives, would result in the loss of about 200 acres of a relatively pristine basin south of Lead. The impact of installing the 9,000-foot effluent transmission line from HMC to Grizzly Gulch would also not occur. Other minor construction impacts associated with the development of any of the proposed alternatives would likewise be avoided.

Failure to provide sewage treatment in the Lead-Deadwood area would not affect vegetation. But aquatic life in the involved streams would remain suppressed. Whitewood Creek would continue to support little biological life, and the biological productivity of the Belle Fourche and Cheyenne Rivers would remain impaired. A report entitled "Pollution of the Belle Fourche and Cheyenne Rivers," written by the South Dakota Department of Game, Fish and Parks, cites that mining and sanitary wastes in Whitewood Creek pollute the Belle Fourche and Cheyenne Rivers for 110 miles below the HMC discharge at Gold Run Creek.

SENSORY IMPACTS--AESTHETICS, ODOR, AND NOISE

Lower Deadwood AWT--I-E(1) and Secondary Treatment--I-E(3) Systems

Development of either of the separate treatment systems would affect both the aesthetics and noise levels in the lower Deadwood and Grizzly Gulch areas, both during construction and after project completion. Aesthetics of the Lead and Deadwood areas would be benefited by implementation of either system.

During the construction phase of either treatment plant, excavation and the presence of stockpiled materials and construction equipment would represent a visual change. Use of heavy equipment and trucks hauling materials to the project site would increase noise and congest local roadways. Because the prospective plant site is relatively isolated from residential areas, these impacts would be felt less than if the site

were near homes. However, construction activities would be visible from U.S. Route 85. The scale of impact would be slightly greater for the AWT--I-E(1) plant because it requires more construction.

Construction of the separate HMC tailings pond and possible land application system would impair the visual quality of Grizzly Gulch. These impacts would, for the most part, go unnoticed because of the relative seclusion of the project area. Also, trucks hauling materials and equipment to Grizzly Gulch would increase local noise levels and have a visual impact. The 20 households located at the mouth of Grizzly Gulch would be the most affected.

The lower Deadwood and Grizzly Gulch areas would be visually impacted by the operation of either of the proposed separate treatment systems. As mentioned before, the lower Deadwood plant site is visible from the rodeo grounds and U.S. Route 85, but a well-landscaped plant at this location should not be objectionable. Conversely, a treatment plant upset (both the AWT and secondary processes are subject to occasional failure) could result in odorous conditions at the Deadwood rodeo grounds and surrounding area.

The separate HMC waste treatment process would change the appearance of Grizzly Gulch, but the seclusion of the site would lessen objectionable impacts. A separate HMC tailings pond, which is part of the Lower Deadwood AWT Treatment System--I-E(1) or Secondary Treatment System--I-E(3), would have a visual impact similar to the combined tailings-wastewater pond described below for the land-based system; 200 acres of forested land would eventually be inundated with wastewater and tailings. However, a separate HMC tailings pond would not contain domestic wastes, so significant odor problems would not result.

Should HMC build a separate land-based treatment system, an option available with I-E(1) or I-E(3), the visual impact would be similar to, but of a lesser scale than, that for the combined Grizzly Gulch Land-based Treatment System--III-E(1). The combined system would affect a much larger land area.

In contrast, if HMC developed a physical-chemical plant at Lead, the other HMC option under separate systems I-E(1) and I-E(3), the visual impacts associated with a separate HMC land-based treatment system would be avoided.

Operation of either treatment plant alternative would improve the appearance of Gold Run and Whitewood Creeks, which run through Lead and Deadwood. Presently, these creeks function as open sewers; streamflow is leaden-gray and emits odors of

cyanide and raw sewage. Removal of industrial wastes, which is assumed to occur with either alternative, would have the greatest visual benefit. Collection and treatment of domestic wastes would lessen offensive odors and would also provide an improvement in stream aesthetics.

Because industrial wastes would be removed, stream aesthetics in the reach between Lead and Deadwood would be equally improved with either alternative. Below lower Deadwood, stream aesthetics would be benefited slightly more with installation of the Lower Deadwood AWT system--I-E(1) because pollution from domestic wastes would be almost entirely eliminated. Implementation of the Lower Deadwood Secondary Treatment System--I-E(3) would result in a zone of slight pollution below the plant outfall. The visual and odor effects of this zone should not be noticeable to most people.

Grizzly Gulch Land-based Treatment System--III-E(1)

Construction of the Grizzly Gulch Land-based Treatment System would also cause increases in local noise and congestion of local roadways. The small community at the mouth of Grizzly Gulch would be most affected. In addition, the pristine visual character of the application site would be changed by the construction of access roads and installation of effluent distribution lines.

Most of the construction impacts--access roads, irrigation lines, etc.--would permanently affect the scenery of the 1,900-acre effluent application site, and the tailings-wastewater storage pond would change the appearance of Grizzly Gulch. As mentioned previously under "Vegetation and Wildlife," the application of 3.0 feet of additional water to the forested site is expected to change onsite vegetation. The extent of visual impact caused by changes in vegetation is not known.

Second, the combined tailings-wastewater storage pond would receive raw domestic wastes. Consequently, the impoundment may be odorous. The remoteness of the pond site would help to lessen this impact.

Last, local aesthetics of the lower Deadwood and Pluma areas would be slightly impaired by installation of pump stations. Additionally, the pump stations may cause localized odorous conditions.

The operation of the combined Grizzly Gulch Land-based Treatment System--III-E(1) would afford about the same benefit to community aesthetics as the Lower Deadwood AWT Treatment System--I-E(1).

No Action Alternative--IV

A no action approach to wastewater management in the Lead-Deadwood area would have negative as well as positive impacts on the sensory environment.

Negative impacts would include continuation of odors along Whitewood Creek and reduced stream aesthetics due to severe pollution by industrial and municipal wastes. Positive impacts would include avoidance of the construction disturbances accompanying all three treatment alternatives and the preservation of Grizzly Gulch as a pristine landscape.

LAND USE AND DEVELOPMENT

Lower Deadwood AWT--I-E(1) and Secondary Treatment--I-E(3) Systems

Development in the Lead-Deadwood area is restricted by mountainous topography; building is limited to drainage bottoms and the less steep mountain slopes. As a result, housing densities are high, especially for a rural area, averaging about nine units per acre. Land for new construction in the Lead-Deadwood area is generally unavailable. Because of this land shortage, land uses are highly competitive and proposals to commit developable land for a use such as sewage disposal are potentially controversial.

The lower Deadwood site, which is common to both alternatives I-E(1) and I-E(3), has been designated for commercial and industrial land use by the Deadwood Comprehensive Plan. This parcel is the largest contiguous vacant industrial site in Deadwood. The installation of a sewage treatment plant on this site would not violate the plan, but such use would preclude the use of this land for other industrial development.

In contrast, the South Dakota Department of Highways owns right-of-way to a portion of the prospective plant site. Consequently, land use conflicts between the District and the State are anticipated. The conflicts are more pronounced for construction of the Lower Deadwood AWT Treatment System--I-E(1) because it has greater site requirements.

Development of the separate HMC treatment processes (tailings pond and possible land-based or physical-chemical treatment systems) would be on land owned by HMC.

Development of either alternative is not expected to affect population growth or future development trends in the Lead-Deadwood service area. Both the Lead and Deadwood areas have been losing population in past decades; between 1940 and 1970

population dropped by 33%. Both HMC employment and tourism, which together constitute the major segment of the local economy, are expected to hold stable throughout the planning period. Influx of new industry is not anticipated. Consequently, the treatment plants have been devised to service a stabilized population. New sewage collection would be provided only to presently developed areas. Sewering of large tracts of vacant land has not been planned.

Grizzly Gulch Land-based Treatment System--III-E(1)

The use of 1,900 acres near Grizzly Gulch for land-based treatment would not compete with urban development because most of the acreage is owned by HMC or the Federal Government and the land is not contiguous to Lead or Deadwood city limits. The acquisition of privately owned parcels, which represent only a small percentage of the site, should not entail serious conflict because the land is undeveloped. Relocation of homes or businesses is not required.

Since about 20% of the land is publicly owned--by either the Bureau of Land Management or the Forest Service--it is currently available for public recreational activities such as hunting and hiking. Use of this land for wastewater disposal would eliminate public use of this acreage. Acquisition of this public land by the District would evoke opposition from special interest groups as well as the involved Federal agencies.

Land for pump station development at lower Deadwood and Pluma should not present land use conflicts or acquisition problems.

Because the land-based system would service the same number of people as the conventional systems in lower Deadwood, its impact on growth and development trends would be similar to that of either treatment plant. None of the proposed alternatives is expected to stimulate new population growth at the public's expense.

No Action Alternative--IV

Although none of the proposed alternatives is expected to entice new development, adoption of a do nothing policy could cause a loss of population as well as prevent new development. Without sewage treatment, a community is not eligible for FHA assistance loans. As discussed in the next section of this chapter, this ineligibility has and would continue to have a substantial effect on the availability of housing in the Lead-Deadwood area.

SOCIOECONOMIC IMPACTS

Lower Deadwood AWT--I-E(1) and Secondary--I-E(3) Treatment Systems

The most important advantage of building either treatment plant would be the protection of public health and water resources, both locally and regionally.

Raw sewage contains viruses and pathogens that can be injurious to public health. At present Gold Run and Whitewood Creeks function as open sewers; other smaller creeks are also polluted by raw or partially treated sewage. Consequently, contamination of private wells, which has been documented in Nevada Gulch, and public exposure to pathogens present a health hazard, both in Lead-Deadwood and communities downstream. Any well-designed sewage treatment system could abate this problem.

Second, impoundment and treatment of HMC wastes would protect downstream water resources, namely the Belle Fourche and Cheyenne Rivers as well as the Oahe Reservoir. Mill tailings, which represent the most significant pollution problem, presently lessen the utility of these waters, especially Whitewood Creek. Removal of the tailings would allow water in Whitewood Creek to be used beneficially, such as for irrigation and municipal water supply.

Third, the implementation of sewage treatment in the Lead-Deadwood area would eliminate the odors attributed to industrial and raw domestic wastes, improve local aesthetics, and therefore add to the desirability and economic value of personal property. Residences in the vicinity of the Imhoff tanks and along Whitewood Creek would receive the most benefit.

Fourth, installation of a federally acceptable sewage treatment system would qualify Lead and Deadwood for FHA assistance loans. As a result of ineligibility for Federal assistance, there is a housing shortage in Lead and Deadwood. Reportedly, 30% of the dwelling units in the area are "substandard." Consequently, about 1,000 people have moved from the district to surrounding communities--Sturgis, Spearfish and Whitewood--during the past 5 years.

The major benefit which the AWT alternative I-E(1) provides over the secondary treatment system I-E(3) is the possibility of establishing a cold water fishery. A trout fishery would add to the recreational and aesthetic value of Whitewood Creek. It would also have a positive (though probably small) effect on local tourism.

Adequate sewage treatment costs the average American household from \$3.00 to \$8.00 per month. The monthly costs of the proposed Lower Deadwood AWT--I-E(1) and Secondary Treatment--I-E(3) Systems are, respectively, \$17.36 and \$10.11. Whether these costs are acceptable to the citizens of the District will depend on the individual. However, the District has expressed doubt that implementation of the AWT system would meet public approval.

Adoption of a separate treatment system would require that HMC provide its own industrial treatment. The financial impact of this decision on HMC, the major employer in the district, is unknown at this time.

Grizzly Gulch Land-based Treatment System--III-E(1)

The socioeconomic benefits accompanying implementation of the land-based alternative parallel those listed previously for the Lower Deadwood AWT System--I-E(1).

The principal advantage of the combined Grizzly Gulch Land-based System over the Lower Deadwood AWT System is its slightly lower annual cost for operation. This results in a monthly household cost of \$17.10 versus \$17.36 for the Lower Deadwood AWT System. However, the combined land-based system may not be implementable because its capital cost is greater than available grant monies.

No Action Alternative--IV

The social advantages of the no action alternative are principally local and monetary. The people residing in Lead and Deadwood would continue to pay little or nothing for sewage disposal. Also, the continuation of the no action alternative would obviously avoid the construction impacts on residences, local businesses and tourism associated with the three proposed systems.

An obvious social disadvantage of the no action alternative would be the continuation of public health problems in the Lead-Deadwood area. This holds true especially for the Nevada Gulch, portions of the Deadwood Creek, and the Grizzly Gulch areas, where poorly designed septic systems threaten domestic water supplies. In addition, the odors and visual disamenities accompanying the degraded condition of Whitewood Creek would persist with the no action alternative. The impact of the creek's unsightly condition on local community pride and on the tourist industry is difficult to measure.

Failure to provide sewage treatment in the Lead-Deadwood area would continue to negatively affect the region. Water from

Whitewood Creek degrades the Belle Fourche and Cheyenne Rivers as well as Oahe Reservoir. Biological life is restricted and the utility of the affected water is lessened.

The choice to do nothing also has some significant economic impacts. Without sewage treatment, federally subsidized housing funds will continue to be unavailable to the Lead-Deadwood area. Second, it is apparent that sewage treatment will eventually have to be provided to Lead-Deadwood. It is also possible that treatment standards will become more restrictive. Postponing sewage facility construction will probably increase local cost. Due to inflation, construction of a treatment system now would be less expensive than future development.

Last, failure to provide sewage treatment in the Lead-Deadwood area would result in violation of State and Federal wastewater discharge standards. Violation of the discharge permit could result in daily fines of up to \$25,000. In addition, State and Federal agencies could possibly impose other economically punitive measures on the local community.

SUMMARY EVALUATION :

Regardless of the alternative implemented, solving the pollution problem in the Lead-Deadwood area will be costly and will involve environmental tradeoffs. The cost associated with the cold water fishery objective must be put into perspective with (1) the return that would be gained from the investment and (2) the uncertainties about establishing a cold water fishery in Whitewood Creek.

ENGINEERING CONSIDERATIONS

Given existing information, the combined land-based treatment system appears to have the best chance of producing a reliable effluent that would meet existing stream standards in Whitewood Creek. It also has a lower annual cost than the Lower Deadwood AWT System. However, the capital requirement of the combined land-based system is greater than existing State and Federal grant capabilities. Second, acquisition of nearly 1,900 acres for the effluent application site entails negotiations with three Federal agencies as well as private landowners. As a result, this system is expected to be difficult, if not impossible, to implement.

In contrast, the Lower Deadwood AWT alternative has a lower capital requirement, which is achievable within existing grant limitations, than does the land-based system. This system may fulfill enacted State water quality goals and poses no serious land acquisition problems. Of the three proposed wastewater

management alternatives, the Lower Deadwood AWT System should be the easiest to implement. The principal disadvantages of this system are its high annual cost, complexity of operation, production of large quantities of sludge (requiring additional management), and uncertainties about its capability to produce an acceptable and reliable effluent.

The secondary treatment alternative at lower Deadwood has definite cost advantages over the two high level treatment alternatives and a similar benefit to regional water quality. This system would not satisfy existing effluent NPDES Discharge Permit limitations. Analysis of this alternative is presented to provide a compromise solution by showing the relative advantages and disadvantages of a reduced level of treatment.

ENVIRONMENTAL IMPACT CONSIDERATIONS

The major environmental benefit of all three alternatives is that they would eliminate the discharge of untreated wastes into area streams. The alternatives would provide about the same benefits to regional water quality. However, local water quality in Whitewood Creek would be most benefited by the implementation of either of the two advanced wastewater treatment alternatives--I-E(1) or III-E(1). With available information, it is anticipated that the combined land-based treatment system would be the most beneficial to Whitewood Creek because it may produce a more reliable and purer effluent than would the Lower Deadwood AWT System--I-E(1) and because it would augment streamflow in the upper reaches of Whitewood and Yellow Creeks during the summer low flow period.

Each alternative would also have adverse environmental trade-offs that must be weighed in evaluating the three systems. Adverse environmental effects are associated to varying degrees with both the construction and operation of these alternatives. The major adverse impact of providing wastewater management in the Lead-Deadwood area is development of the HMC tailings pond. This impact occurs with all of the proposed alternatives and thus does not provide a basis for comparison, except with the no action plan.

The combined Grizzly Gulch Land-based Treatment System--III-E(1) would involve the greatest environmental change during construction and operation. To implement this system, 1,900 acres would have to be developed as an application site. During operation, an additional 3.0 feet of water over natural precipitation would be applied to the semiarid ecosystem. Although it is not certain, it is expected that this additional water would have significant environmental effects. The effects of some of the wastewater's constituents,

especially heavy metals, are also unknown but could be potentially detrimental.

Either separate treatment system, I-E(1) or I-E(3), with land-based treatment of HMC's wastes would have environmental effects similar to, but on a smaller scale than, those for the combined land-based alternative. Systems I-E(1) and I-E(3) with HMC's wastes processed separately in a physical-chemical treatment plant would have the least amount of adverse environmental effects.

The major conclusion of this competitive evaluation is that there would be little difference in the environmental effects of the three alternatives if HMC elects to use a separate land-based system.



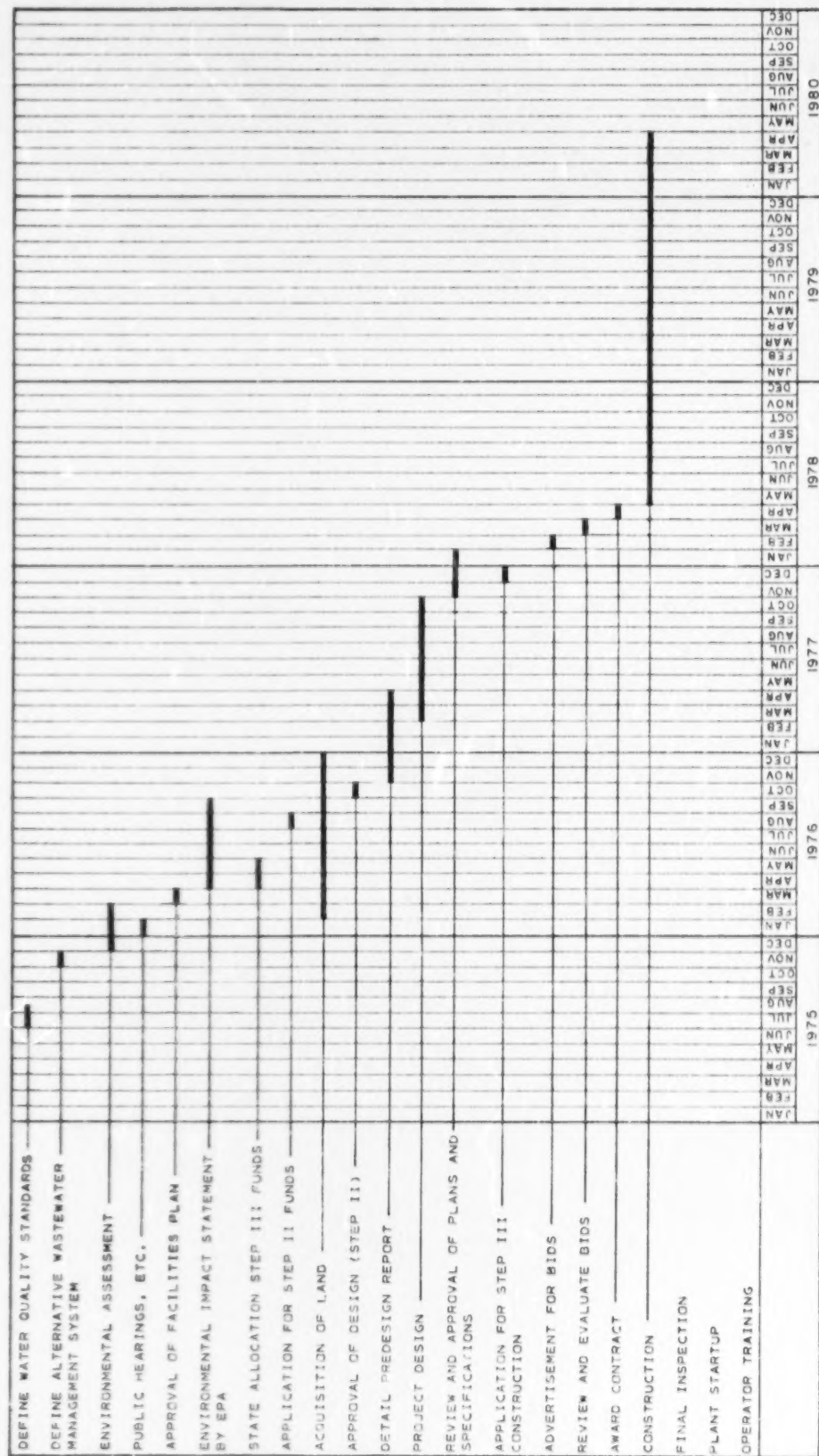


FIGURE 7.2
PRELIMINARY IMPLEMENTATION SCHEDULE
LOWER DEADWOOD ADVANCED WASTEWATER TREATMENT SYSTEM I-E(1)

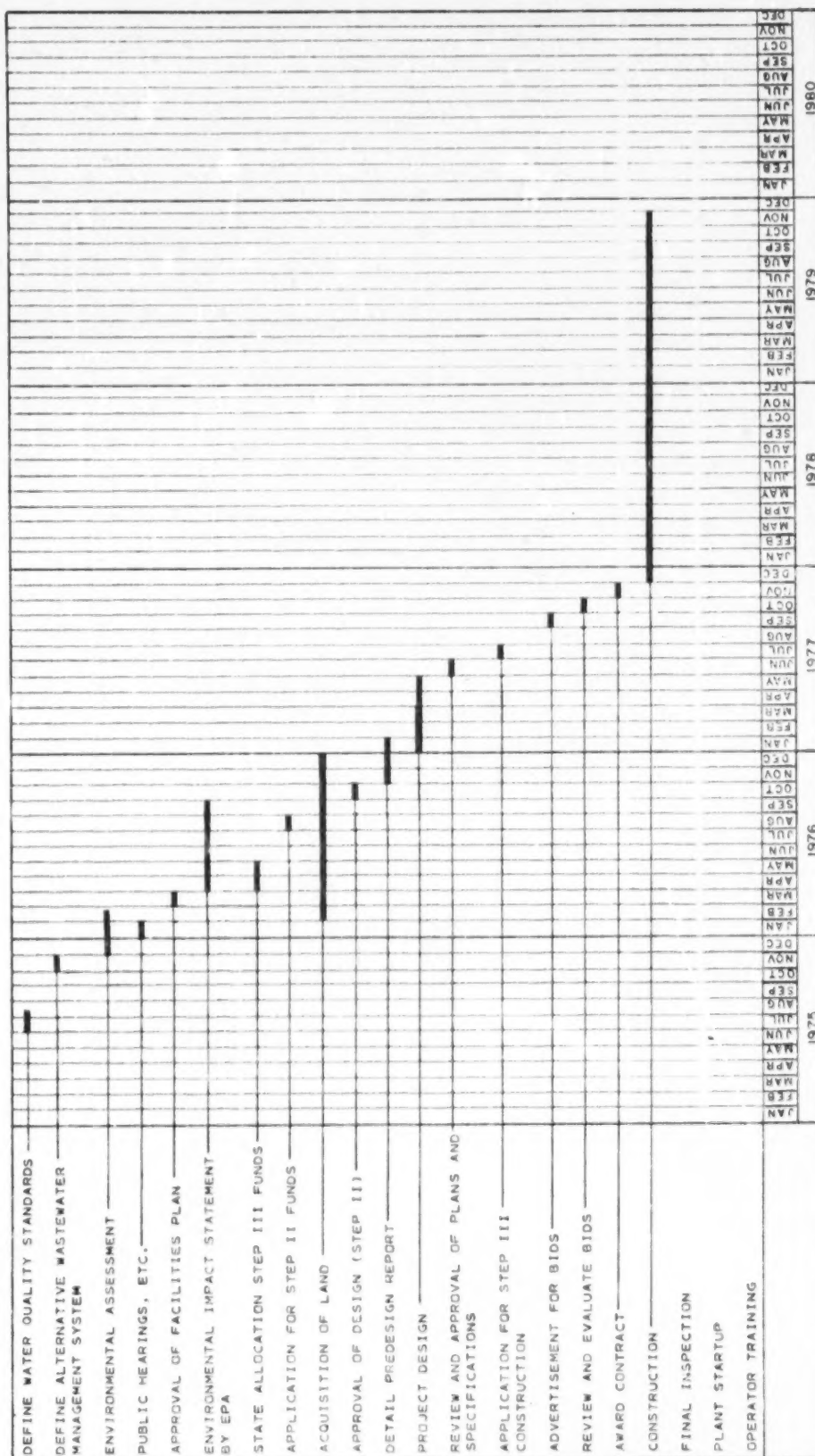


FIGURE 7.3
 PRELIMINARY IMPLEMENTATION SCHEDULE
 LOWER DEADWOOD SECONDARY TREATMENT SYSTEM I-E(3)



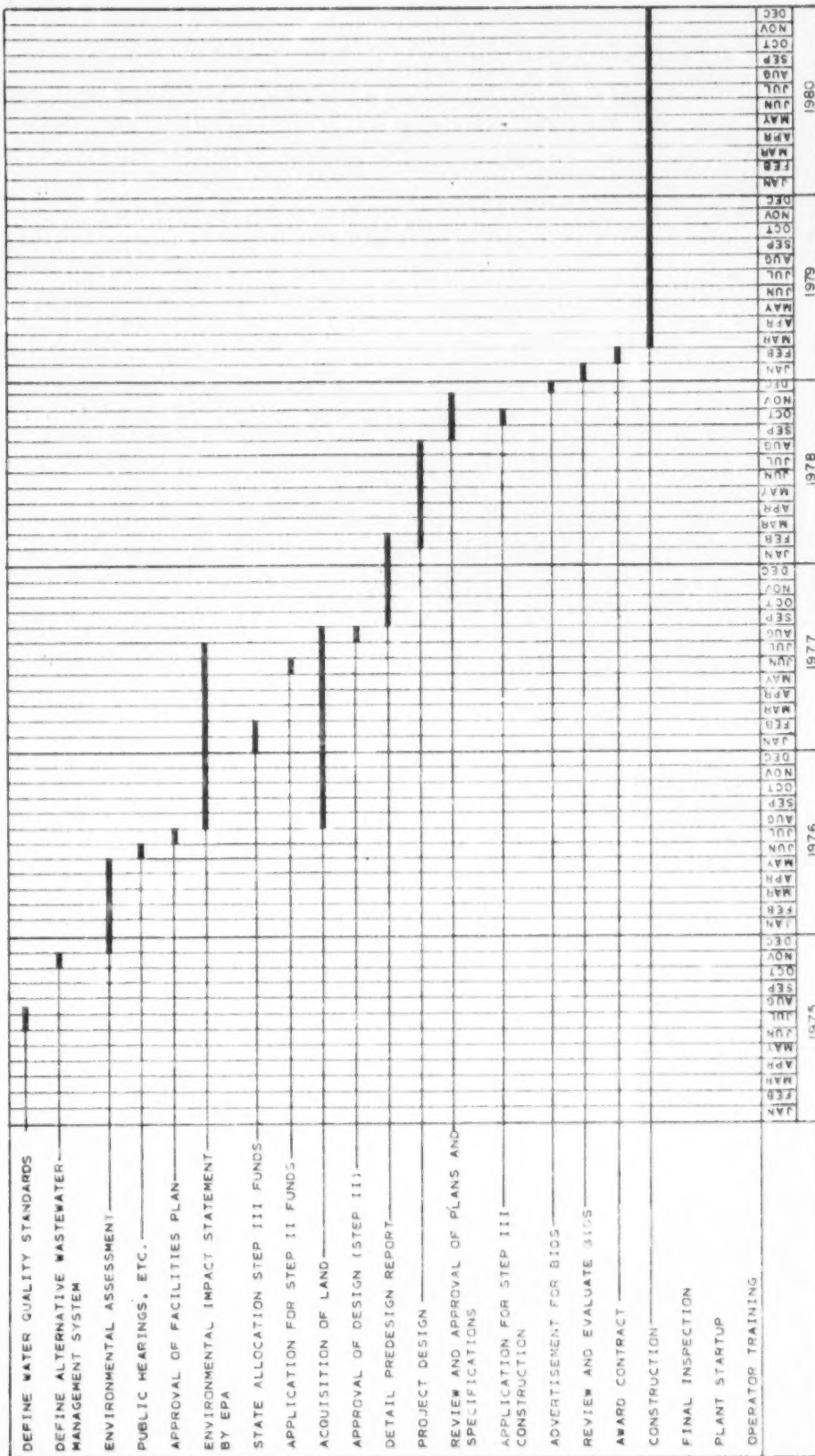


FIGURE 7.4
PRELIMINARY IMPLEMENTATION SCHEDULE
GRIZZLY GULCH VICINITY LAND-BASED TREATMENT SYSTEM III-E(1)

Chapter 8 SELECTION OF A WASTEWATER MANAGEMENT SYSTEM

After the competitive evaluation, none of the alternatives developed so far appeared to be acceptable to the District or public. As a result, two compromise solutions were considered--a modified Lower Deadwood Secondary System and a new Grizzly Gulch Lagoon System. Also several alternative sites for a wastewater treatment plant were evaluated. This chapter discusses the development of the compromise solutions and the alternative site evaluation. The last section of this chapter documents the public hearings and meetings held during the Facilities Plan process.

DEVELOPMENT AND EVALUATION OF COMPROMISE SOLUTIONS

All of the various wastewater management alternatives developed and evaluated previously failed to meet or satisfy a majority of the Facilities Plan evaluation criteria. The District felt that any of the alternatives discussed in the previous competitive evaluation would be difficult if not impossible to implement for the following reasons:

1. The alternatives would be too costly and would therefore not be approved by the District's residents.
2. The less costly alternatives involved a lower treatment that would not meet the required effluent limitations. Furthermore, it was questioned whether implementing the treatment level required to meet the effluent limitations would assure the establishment of a cold water fishery in Whitewood Creek because of uncertainties associated with the stream's hydrological data and the unknown effects of the existing tailings deposits.
3. Construction of a wastewater treatment facility in lower Deadwood would be unacceptable due to visual and odor problems characteristic of conventionally designed wastewater treatment facilities.

Following the competitive evaluation reported in Chapter 7, a draft Facilities Plan report was completed in July 1975 to present the study findings and the selected system. However, the draft also noted the above concerns about the ability to implement the AWT plant or any system that would meet the required effluent limitations. To alleviate these concerns, the draft report considered the investigation of compromise solutions. These compromise solutions would have lower costs but would not meet the set effluent limitations. Implementation

of any compromise alternative would require modifying the permanent cold water fishery objective.

On the basis of the information in the draft Facilities Plan, the District sought to get the effluent limitations lowered. Two legal actions resulted. First, the State of South Dakota changed the stream classification of Whitewood Creek below Deadwood from a permanent to a marginal cold water fishery. Second, on 5 March 1976, State Department of Environmental Protection (DEP) issued an order that waived the water quality objective to allow secondary treatment of the District's wastes with the provision for upgrading the treatment system by 1 July 1988 to meet the cold water fishery objective if future evidence shows that Whitewood Creek will rehabilitate itself by that date.

This order alleviated the concern about meeting the required effluent limitations. Also, the order helped with the concern about cost by allowing the consideration of less costly lower level treatment. Costs were further reduced by revising the sewage collection system. Specifically, planned service to the outlying areas of Terraville, Deer Mountain, Terry Peak/Bald Mountain, and Nevada Gulch/Fantail was eliminated because of the high cost associated with serving a proportionately small number of homes. The District also reviewed the number of homes to be served by the revised collection system. As a result, the homes to be served increased from 2,500 to 3,000.

Finally, the concern about aesthetic and odor impacts was considered in the development of the compromise solutions. Two compromise systems were developed for a final competitive evaluation. One of the systems was the lower Deadwood secondary treatment plant, which was already considered in the above evaluation. This system has been modified as indicated below to meet the concerns about visual and odor problems:

- The plant will include a dechlorination and effluent aeration facility in order to meet the stream's chlorine water quality standard.
- The entire plant will be housed in a building in order to decrease the visual impact on lower Deadwood and to facilitate the collection and control of odors.
- The plant will include odor control equipment to cleanse any odors originating from the treatment facility.

The second system was a newly developed Grizzly Gulch lagoon treatment system. This system involves the collection and transport of the District's wastewater to an aerated lagoon

and winter storage reservoir in Grizzly Gulch. Effluent from the system would be discharged into Grizzly Creek and would reach Whitewood Creek just above Pluma. Treatment of the District's wastewater would be provided by a 2- to 4-day detention time aerated lagoon located in a side branch of Grizzly Gulch and the 200-day detention time winter storage reservoir located on the main stem of Grizzly Gulch. Effluent disinfection and dechlorination facilities would be provided, although it is not anticipated that operation of these facilities would be needed to achieve the bacterial standards.

The modified Lower Deadwood Secondary System and the Grizzly Gulch Lagoon System have been evaluated in terms of engineering, economic, and environmental considerations. This evaluation is presented in detail in the Environmental Assessment Report. On the basis of the competitive evaluation and meetings with Federal and State agencies, the Lower Deadwood Secondary Treatment System has been selected as the most cost-effective and environmentally sound interim alternative. This system will meet the new required effluent limitations and will be a major step toward solving the Lead-Deadwood area pollution problem.

ALTERNATIVE TREATMENT PLANT SITES

In addition to the above competitive evaluation, three alternative sites were examined for the District's wastewater treatment plant currently proposed to be built near the rodeo grounds in lower Deadwood. This investigation, discussed below, indicated that the lower Deadwood site near the rodeo grounds is the best location for the treatment plant in terms of engineering and economic factors.

DUMP SITE

The first alternative site, referred to as the dump site, is located just north of the Highway Alternate 14 bridge over Whitewood Creek at the northern city limits of Deadwood. This site encompasses the area presently occupied by the old Deadwood municipal dump on the west bank of Whitewood Creek. Access to the site for the gravity sewer system would be along the west bank of Whitewood Creek under the Highway bridge. Surface access for maintenance and service vehicles would be from a new road constructed from the west approach to the Whitewood Creek bridge on Alternative 14 near the present dirt road to the Deadwood municipal dump.

The dump site has three major advantages. First, the major inhabited areas of Deadwood are further from the dump site than from the proposed rodeo grounds site. Second, this site offers the potential for a lower initial construction cost because the treatment facility would not have to be housed in

order to be aesthetically acceptable to the community. Third, construction of a treatment facility on the dump site instead of the rodeo grounds site would free the rodeo grounds site for potential industrial development.

The major disadvantage of the dump site is its small awkwardly shaped size. Due to the size limitation of the dump site a treatment facility even more compact than the one presently envisioned for the rodeo grounds site would have to be constructed. Expansion of the treatment facility to increase capacity or to add additional advanced wastewater treatment processes to upgrade effluent quality would be limited. The dump site does not appear to have enough area to allow the construction of the presently envisioned treatment processes and any additional wastewater treatment processes such as filtration.

Another major disadvantage of the dump site is its poor soil and foundation conditions. The existing old landfills would require either expensive and exotic foundation designs or complete excavation and replacement with extensive quantities of fill material. Because this site would constitute the west bank of Whitewood Creek, extensive channelization and embankment production would be required in order to protect the treatment plant during high streamflows and floods. Access to the dump site would be quite steep depending on the elevation of the plant for flood protection and could present problems in the design of an adequate service roadway.

The dump site was eliminated from further consideration due to its small amount of available area, which would limit future expansion, and the construction problems associated with excavation of the site and replacement with dump fill material.

DREDGE SITE

The second alternative site is the dredge site, which is located approximately 1.75 miles downstream of the dump site on the west bank of Whitewood Creek near the present location of an old dredge. Whitewood Creek Canyon widens somewhat at this point and could be used as a site for a wastewater treatment plant with access provided by the old Chicago and Western railroad right-of-way.

The major advantage to this site is its remote location from the inhabited areas of Deadwood. The site would not require the installation of special odor control equipment.

The site's remote location is also a major disadvantage because it would require the construction of additional interceptors, access roadways and bridges along with long power lines to provide electrical power to the site.

The site is also small and would require a compact design similar to that envisioned for the lower rodeo grounds. Expansion at this site would be limited and would require special construction techniques.

Because the plant would be located some distance from Deadwood, it would be somewhat more difficult to operate and maintain. The biological treatment processes would experience operating difficulties from the severe winter weather because the remote plant would not need to be housed for aesthetic and odor control purposes.

The dredge site would require extensive flood protection and channelization of Whitewood Creek in order to assure operation during high flows and flood periods. Also, the site has a gold mine and could present acquisition problems because of the mineral resources. Finally, access to the dredge site would require extensive widening and improvement of the existing Chicago and Western railroad bed. Furthermore, three bridges would have to be replaced with wider bridges capable of handling large semitrucks.

This site was eliminated from future considerations due to the high costs of providing adequate access, power and flood protection and due to its limited area for expansion of the treatment facility.

RIVER SITE

The river site is located approximately .5 mile downstream of the dredge site. It is quite similar to the dredge site except it is somewhat further from the City of Deadwood and is in a location more vulnerable to floods. The added distance from Deadwood increases the costs because of the need for longer access roads, power lines and sewer interceptors. The river site is small and would require an extremely compact treatment design similar to that for the rodeo grounds site. It would also have operating problems as noted for the dredge site and was eliminated as a feasible alternative for many of the same reasons that the dredge site was not considered feasible.

PUBLIC HEARINGS AND MEETINGS

Since the Lead-Deadwood Sanitary District No. 1 was organized in 1969, there have been numerous public hearings and meetings held in connection with developing various wastewater management alternatives. Listed below are the hearings and meetings that have been held since CH2M HILL became the District's consulting engineer in August of 1974:

PROJECT REVIEW MEETING, 17 and 18 MARCH 1975, NORTHERN HILLS
HOLIDAY INN, SPEARFISH, SOUTH DAKOTA

Representatives from CH2M HILL, DEP, EPA, U.S. Forest Service, Soil Conservation Service (SCS), Bureau of Land Management (BLM), HMC, USWA Local 7044, FmHA, SCVA and LDS No. 1 met at the Northern Hills Holiday Inn and discussed various treatment and collection system alternatives. The three treatment options presented by CH2M HILL were 1) advanced biological, 2) physical- chemical and 3) land treatment. There was also discussion on the cost of the project and how the District could finance its share of the cost.

PROJECT REVIEW MEETING, 28 APRIL 1975, HOWARD JOHNSON MOTOR
LODGE, RAPID CITY, SOUTH DAKOTA

At this meeting it was decided that the District and HMC should consider separate systems. DEP recommended that the District investigate a stabilization pond north of Whitewood for Level 3 treatment and that HMC study options that would assure Level 1 treatment. Besides DEP, other organizations represented were EPA, BLM, U.S. Forest Service, HMC, CH2M HILL, USWA Local 7044, Bureau of Mines, Sixth Planning and Development District, and LDS No. 1.

SOUTH DAKOTA BOARD OF ENVIRONMENTAL PROTECTION (BEP) HEARING,
17 JULY 1975, DEADWOOD, SOUTH DAKOTA

At this hearing, the District asked that South Dakota Water Quality Standard for Whitewood Creek from I-90 to the Deadwood city limits be changed. Representing the District were its attorney, Manager, Board Treasurer, engineer (CH2M HILL) and local citizens. The DEP gave testimony opposing the District's request.

SOUTH DAKOTA BOARD OF ENVIRONMENTAL PROTECTION MEETING,
14 AUGUST 1975, PIERRE, SOUTH DAKOTA

Representing the District at this meeting were its attorney, Manager and Board President. BEP changed the classification of Whitewood Creek from the I-90 bridge to the north Deadwood city limits from a cold water permanent fishery to a cold water marginal fishery. The BEP also instructed the DEP to meet with the District and draw up a mutually agreeable enforcement order.

PROJECT REVIEW MEETING, 22 DECEMBER 1975, SOUTH DAKOTA SCHOOL
OF MINES AND TECHNOLOGY, RAPID CITY, SOUTH DAKOTA

At this meeting at the Surbeck Center on the School of Mines campus, three alternatives were discussed. These were the

Grizzly Gulch Lagoon System, the Lower Deadwood Secondary System and the Bauer, Sheaffer and Lear Plan. In attendance were representatives of EPA, DEP, BLM, USWA Local 7044, Sierra Club, HMC, CH2M HILL, Senator George McGovern's office, Sixth Planning and Development District, Lawrence County Taxpayers Association, interested citizens and the LDS No. 1.

LEAD-DEADWOOD SANITARY DISTRICT NO. 1 PUBLIC HEARINGS,
10 and 11 FEBRUARY 1976, DEADWOOD, SOUTH DAKOTA

In February of 1976, the District held two public hearings on the Facilities Plan prepared by CH2M HILL. The Affidavit of Publication of Notice of Public Hearing follows this chapter. At these hearings the public asked many questions and gave statements concerning the alternatives. Approximately 150 people attended the two hearings. It appeared that most of the people in attendance favored the Lower Deadwood Secondary System over the other two alternatives.

AFFIDAVIT OF PUBLICATION

STATE OF SOUTH DAKOTA, ss.
COUNTY OF LAWRENCE

James W. Keith, of said county and state, being duly sworn, on his oath, says: That the Deadwood Pioneer-Times is a legal newspaper of general circulation, printed and published in Lead, in said county and state, by the Seaton Publishing Company, and has been such a newspaper during the times hereinafter mentioned; and that I, James W. Keith, the undersigned, am the Business Manager of the said newspaper, in charge of the advertising department thereof, and have personal knowledge of all the facts in this affidavit, and that the advertisement headed

Notice of Public Hearing

Sanitary Dist.

a printed copy of which is hereto attached, was printed in said newspaper for 2 successive and consecutive issues, the respective publications thereof being made on January 9, 1976 and on _____, 19____.

and the last publication thereof on January 10, 1976

and that the full amount of fees charged for publishing the same, to-wit: the sum of \$ 35.78, inures solely to the benefit of aforesaid publisher and that no arrangement or understanding for a division thereof has been made with any person other than the publisher, and that no part thereof has been agreed to be paid to any other person whomsoever.

James W. Keith

Subscribed and sworn to before me this 11

day of January, 1976

Bruce E. Egan

Notary Public, Lawrence County, S. Dak.

My commission expires April 28, 1974

11-24-80

**NOTICE OF
LEAD-DEADWOOD SANITARY DISTRICT NO. 1
PUBLIC HEARING ON WASTE WATER
TREATMENT ALTERNATIVES**

NOTICE IS HEREBY GIVEN that on Tuesday, the 10th day of February, 1976, commencing at 7:00 o'clock p.m., and on Wednesday, the 11th day of February, 1976 commencing at 1:30 o'clock p.m., in the Deadwood Junior High School Auditorium in Deadwood, South Dakota a public hearing will be held to accept public input and to afford concerned citizens adequate opportunity to express their views on environmental issues and other issues of the proposed treatment works and alternatives presently under consideration by Lead-Deadwood Sanitary District No. 1, which are described as follows:

1). **GRIZZLY GULCH LAGOON SYSTEM.** This alternative consists of an aerated lagoon and waste water storage dam to be located in lower Grizzly Gulch, between the Homestake air shaft and the Grizzly Gulch residential area and will treat the domestic wastes of the City of Lead, the City of Deadwood and other outlying areas presently within the boundaries of Lead-Deadwood Sanitary District No. 1. Lead wastes and Deadwood wastes would be pumped separately to the lagoon site for treatment. Effluent from the system will be discharged into Grizzly creek immediately below the storage area. Effluent will meet secondary treatment requirements.

2). **LOWER DEADWOOD MECHANICAL TREATMENT PLANT.** This alternative includes an activated biological filter mechanical treatment plant located between the Rodeo Grounds parking lot and the slag pile in Lower Deadwood. This is the area that is presently being used for an auto salvage lot, horse stables and as a location for bulk gasoline storage. Wastes from the City of Lead, the City of Deadwood and other outlying areas included within Lead-Deadwood Sanitary District No. 1 would flow by gravity to the treatment plant location and pumped through the treatment system. Effluents from the plant will be discharged into Whitewood Creek at the northerly edge of the Deadwood City Limits. Effluents from this plant will meet secondary treatment requirements.

3). **COMBINED DOMESTIC-INDUSTRIAL GRIZZLY GULCH SYSTEM.** This system would treat the combined wastes of the Cities of Lead and Deadwood and the outlying areas within the District and Homestake Mining Company wastes. These combined wastes would be pumped to a storage facility in upper Grizzly Gulch and treated through application of the waste waters onto land in the Grizzly Gulch area. An alternative within this system would include treatment of Deadwood wastes through application upon land in lower Deadwood or other treatment of Deadwood wastes at another site. Effluent from this system would meet stream standards.

Oral statements on the subject of the hearing will be received from interested persons and individuals, organizations, groups and local, state, federal governments and agencies. Written statements will also be received at or in advance of the hearing and should be directed to Francis Toscana, Manager, Lead-Deadwood Sanitary District No. 1, P.O. Box 51, Deadwood, South Dakota, 57732.

A copy of the draft facilities plan and environmental assessment and other detailed information on the above alternatives including costs and financial information will be available at the hearing or may be obtained from Francis Toscana, Manager, Lead-Deadwood Sanitary District No. 1. In addition, these reports and information will be available for public inspection at the following locations:

- 1). Deadwood Carnegie Library, Deadwood, South Dakota
- 2). Homestake Library, Lead, South Dakota

Dated this 7th day of January, 1976.

LEAD-DEADWOOD SANITARY DISTRICT NO. 1

By: Norman Bakke
President
Jan. 9, 1976

Table 7.1
ENGINEERING COMPARISONS

PARAMETER	I-E(1) LOWER DEADWOOD AWT	I-E(3) LOWER DEADWOOD SECONDARY	III-E(1) LAND-BASED TREATMENT NEAR GRIZZLY GULCH	IV NO ACTION	RANK ORDER (Most Preferable to Least)
Project Cost	LDSD#1 \$ 7,391,700 HMC 4,955,000 Total 12,346,700	LDSD#1 \$ 5,517,700 HMC 4,955,000 Total 10,472,700	LDSD#1 \$11,194,000 HMC 7,327,000 Total 18,521,000	The social and monetary costs of continuing no sewage treatment in the District are anticipated to be high. But this cost is difficult to quantify and cannot be estimated at this time. Consequently, the cost of no action has not been included in the ranking of alternatives.	I-E(3) I-E(1) III-E(1)
Grant Requirement	LDSD#1 5,913,000 HMC --- Total 5,913,000	LDSD#1 4,414,000 HMC --- Total 4,414,000	LDSD#1 8,955,000 HMC 5,862,000 Total 14,817,000		I-E(3) I-E(1) III-E(1)
Local Cost	LDSD#1 1,478,700 HMC 4,955,000 Total 6,433,700	LDSD#1 1,103,700 HMC 4,955,000 Total 6,058,700	LDSD#1 2,239,200 HMC 1,465,000 Total 3,704,200		I-E(3) I-E(1) III-E(1)
Capital Recovery	LDSD#1 139,600 HMC 1,307,000 Total 1,446,600	LDSD#1 104,200 HMC 1,307,000 Total 1,411,200	LDSD#1 211,000 HMC 386,000 Total 597,000		I-E(3) I-E(1) III-E(1)
Annual O&M	LDSD#1 381,200 HMC 270,000 Total 651,200	LDSD#1 199,200 HMC 270,000 Total 469,200	LDSD#1 302,000 HMC 218,000 Total 520,000		I-E(3) III-E(1) I-E(1)
Total Annual Cost	LDSD#1 520,800 HMC 1,577,000 Total 2,097,800	LDSD#1 303,400 HMC 1,577,000 Total 1,880,400	LDSD#1 513,000 HMC 799,000 Total 1,312,000		I-E(3) III-E(1) I-E(1)
Estimated District Monthly Household Cost	\$17.36	\$10.11	\$17.10		I-E(3) III-E(1) I-E(1)
Present Worth	LDSD#1 11,430,000 HMC 7,254,000 Total 18,684,000	LDSD#1 7,628,000 HMC 7,254,000 Total 14,882,000	LDSD#1 14,394,000 HMC 9,183,000 Total 23,577,000		I-E(3) I-E(1) III-E(1)

Ranking of the above economic parameters has been based on lowest costs for LDSD#1. The choice of a different criterion, such as lowest cost for HMC, would result in a different ranking. HMC's costs for alternative I-E(3) differ from those on Tables 5.4 and 5.5 because in this competitive evaluation it was assumed HMC would provide Level 1 treatment under a separate system.

Effluent Quality	BOD ₅ (ave.) 10 mg/l SS 10 mg/l Fecal Coliform <200 mpn/100ml Coliform <1000 mpn/100ml Dissolved Oxygen 7.0 mg/l Residual CL 0.05 mg/l Ammonia Nitrogen <1.0 mg/l	BOD ₅ (ave.) 30 mg/l SS 30 mg/l Fecal Coliform <200 mpn/100ml Coliform <1000 mpn/100ml Dissolved Oxygen 2.0 mg/l Residual CL 1.0 mg/l Ammonia Nitrogen 3.0 mg/l	BOD ₅ (ave.) <10 mg/l SS <10 mg/l Fecal Coliform <200 mpn/100ml Coliform <1000 mpn/100ml Dissolved Oxygen ? mg/l Residual CL <0.05 mg/l Ammonia Nitrogen 0.6 mg/l	III-E(1) I-E(1) I-E(3) IV
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With proper management, this system may fulfill promulgated stream standards. Even though this system represents advanced technology sufficient removals of residual chlorine, chlorides, ammonia-nitrogen and nitrate may not be achieved.

This system may allow development of a cold water fishery in Whitewood Creek.

This system would not comply with existing stream standards.

This system would not allow development of a cold water fishery in Whitewood Creek, but may allow the reestablishment of some aquatic life.

This alternative has the best chance for meeting existing stream standards. However, the fate of cyanide and chlorides is unknown. Problems with hydrogen sulfide may also develop with improper management resulting in violation of stream standards.

This system has a slightly better chance of allowing a cold water fishery in Whitewood Creek.

ENGINEERING COMPARISONS, continued

PARAMETER	I-E(1) LOWER DEADWOOD AWT	I-E(3) LOWER DEADWOOD SECONDARY	III-E(1) LAND-BASED TREATMENT NEAR GRIZZLY GULCH	IV NO ACTION	RANK ORDER (Most Preferable to Least)
Reliability	All alternatives would bypass (over a pre-determined value) storm and domestic wastes from Lead's combined sewer system to Whitewood Creek during intense rain storms. Plant upsets could be common with improper operation; this system requires highly experienced plant operators. Small districts historically have had problems obtaining properly trained O&M personnel.	Same as for I-E(1).	Same as for previous two alternatives.		III-E(1) I-E(3) I-E(1) IV
Flexibility	Additional unit processes could be added to produce desired level of treatment. Additional plant capacity could be provided, but would present land use conflict with the rodeo grounds parking lot.	Plant has been devised to be readily expandable to higher levels of treatment. Additional plant capacity could easily be built because space is readily available on existing site.	System has limited ability to provide additional treatment. Additional process capacity would require enlargement of the storage reservoir and application site.		IV I-E(3) I-E(1) III-E(1)
Resource Commitments	Annual LDES#1 power requirement is 3,100,000 kWh/year and HMC requirement is 600,000 kWh/year. Total annual power is 3,700,000 kWh/year. Highest chemical usage.	Annual LDES#1 power requirement is 2,400,000 kWh/year and HMC requirement is 600,000 kWh/year. Total annual power is 3,000,000 kWh/year. Second highest chemical usage.	Total annual power is 8,300,000 kWh/year. Lowest chemical usage.	No chemical usage.	IV I-E(3) I-E(1), III-E(1)
Land Requirements	6.0 acres. HMC tailings pond would require 200 acres. If HMC developed a land-based treatment system additional acreage would be required.	3.5 acres. HMC treatment processes would have a land requirement similar to that for I-E(1).	200 acres are required for tailings pond. 1900 acres are required for application site.		IV I-E(3) I-E(1) III-E(1)
Implementation	Construction could begin in spring of 1978 and operation could begin in spring of 1980. Design would require construction and operation of pilot plant in the fall of 1976. Voter resistance to high sewerage service charges could prohibit necessary bonding.	Construction could begin in fall of 1977 and operation could begin in fall of 1979. Implementation would require revisions in stream standards for Whitewood Creek. Without revision of stream standards plant would not be eligible for either State or Federal funding.	Construction could begin in the winter of 1978 and operation could begin in fall of 1980 or early 1981. System would require an extensive environmental impact statement due to the involvement of Forest Service and BLM lands. In addition, special use permits must be obtained. System would also involve extensive pilot study to determine pollutant removal and impacts on soil and vegetation. Agreement between the District and HMC would have to be negotiated concerning the operation and maintenance of the treatment facility. Similar to I-E(1) voter resistance to high sewerage charges could prohibit necessary bonding.		I-E(1) I-E(3), III-E(1) IV

Table 7.2
ENVIRONMENTAL IMPACT

PARAMETER	I-E(1) LOWER DEADWOOD AWP	I-E(3) LOWER DEADWOOD SECONDARY	III-E(1) LAND-BASED TREATMENT NEAR GRIZZLY GULCH	IV NO ACTION	RANK ORDER (Most Preferable to Least)
Soil, Geology, Air Quality	Installation of new collection system would expose soil to erosion. Due to steep topography short-term erosion could be significant during inclement weather. Plant construction would expose 15 to 20 acres of soil to short-term erosion. In addition, 55,000 cubic yards of fill material (excavated from another area) would be imported to the plant site. Construction of the HMC tailings dam would involve significant excavation and grading altering geologic forms and exposing soil in the immediate dam site area to erosion. Construction of collection system and plant would cause minor localized air quality degradation, resulting from increased vehicular emissions from construction equipment and dust. Plant operation would attract additional vehicles to lower Deadwood which would have a slight effect on local air quality.	Impact of collection system installation would be analogous to I-E(1). Impact of plant construction would affect the same site. But magnitude of impact would be about 30% less. 27,000 cubic yards of fill material would be imported to the plant site. HMC tailings pond impact would be similar to I-E(1). Plant operation would have a very minor impact on air quality, somewhat less than that discussed for alternative I-E(1).	Impact of collection system installation would be similar to I-E(1) and I-E(3). However, installation of force main from lower Deadwood to Grizzly Gulch results in an additional erosion potential. Development of access roads and effluent transmission lines (over steep topography) would subject soil to significant short-term erosion. Construction of tailings and effluent storage pond would cause erosion and alter local topography. All construction activities would have a temporary impact on air quality, caused by vehicular emissions and dust. The magnitude of these impacts would be much greater than for alternative I-E(1) or I-E(3). Application of additional water on mountain topography would increase erosion and may cause subsidence of the steeper slopes. During pond drawdown tailings would be exposed and could pose dust problems during windy conditions. This problem would be less with a separate (HMC only) system because tailings pond would not be drawn down to same degree.	No construction impact. No operational impact.	IV I-E(3) I-E(1) III-E(1)

ENVIRONMENTAL IMPACT, continued

PARAMETER	I-E(1) LOWER DEADWOOD AMT	I-E(3) LOWER DEADWOOD SECONDARY	III-E(1) LAND-BASED TREATMENT NEAR GRIZZLY GULCH	IV NO ACTION	RANK ORDER (Most Preferable to Least)
Hydrology. Water Quality	Construction of collection system would parallel creeks (especially South Lead Collection System) and may cause physical damage to stream corridor. Plant construction would encroach on Whitewood Creek. In addition, a small creek adjacent to the site would be rerouted to avoid the plant. Construction of a HMC tailings pond (and possibly a land application system) would increase turbidity in area creeks. This impact would be similar to, but somewhat less than, that of the joint system, III-E(1). Due to flow reduction (reduced interbasin water diversions) by HMC and increased sewage collection, Whitewood Creek would be dewatered by about 8.0 cfs between Lead and Deadwood. With proper management, this system may fulfill promulgated stream standards. Even though this system represents advanced technology sufficient removal of residual chlorine, chlorides, ammonia-nitrogen, and nitrate may not be achieved.	Impact of collection system would be same as alternative I-E(1). Construction of this system would not encroach on Whitewood Creek nor require the relocation of a small creek adjacent to the site. Construction of HMC treatment system would have same impact as mentioned for I-E(1). Impact on streamflow would be similar to alternative I-E(1). THIS SYSTEM WOULD NOT COMPLY WITH EXISTING STREAM STANDARDS AND WOULD NOT BE IMPLEMENTED UNLESS THESE STANDARDS WERE REVISED. Although local water quality (Whitewood Creek in vicinity of Deadwood) would not be benefited as much as with alternatives I-E(1) and III-E(1), beneficial impacts on regional water quality would be similar. Special interest and conservation groups may lobby against the relaxation of stream standards in Whitewood Creek.	Impact of collection system would be similar to other alternatives, but would be somewhat greater due to force main construction (along Whitewood and Grizzly Creeks) between lower Deadwood and Grizzly Gulch. Construction of tailings pond, roads, effluent distribution lines, etc., would greatly increase the turbidity and sedimentation of Grizzly Creek. Earthwork on the application site would probably increase turbidity in the upper reaches of Yellow and Whitewood Creeks. This alternative would have similar impacts on streamflow in Whitewood Creek as I-E(1) and I-E(3). However, flow would be slightly increased (compared to alternatives I-E(1) and I-E(3)) between Lead and Deadwood and slightly decreased below Deadwood, due to evapotranspiration and other water losses resulting from effluent storage and land application. With proper operation this alternative has the best chance for meeting existing stream standards. However, the fate of cyanide and chlorides is unknown.	No construction impact. No impact on streamflow in Whitewood Creek. Stream standards would not be met. Tailings in Whitewood Creek would continue to degrade the Belle Fourche and Cheyenne Rivers as well as Caha Reservoir for some 110 miles downstream.	I-E(1), III-E(1) I-E(3) IV

ENVIRONMENTAL IMPACT, continued

PARAMETER	I-E(1) LOWER DEADWOOD AWT	I-E(3) LOWER DEADWOOD SECONDARY	III-E(1) LAND-BASED TREATMENT NEAR GRIZZLY GULCH	IV NO ACTION	RANK ORDER (Most Preferable to Least)
Vegetation, Wildlife	Construction of collection system would tear up lawns and in small cases result in the removal of trees. The most significant impact would result from developing the South Lead Collection System: four 1000' gravity sewers would be built down a steep forested hillside. Where interceptor construction encroaches on stream corridors, some impact on aquatic life may result. Impacts would be most significant in upper reaches of Whitewood Creek. Development of HMC tailings pond, 9000' effluent transmission line and access roads would have a significant impact on Grizzly Gulch; 200 acres would be inundated with mine tailings. Should HMC develop a land-based system near Grizzly Gulch impacts on vegetation and wildlife would be similar, but somewhat less, due to smaller site requirements than those of III-E(1). Operation of AWT plant at Lead and Deadwood would not affect vegetation. But it would have a marked effect on the aquatic productivity of Whitewood Creek. The establishment of a cold water fishery is a possibility. Operation of plant would also benefit semi-aquatic birds and mammals which depend on water for shelter and food. Waterfowl, muskrats, beaver, raccoon are common examples. Should HMC implement a land-based treatment system, impacts on vegetation and wildlife would be similar to III-E(1).	Impact of collection system would be similar to alternative I-E(1). Impacts of HMC activities would be analogous to I-E(1). The operation of this system would greatly improve the aquatic viability of Whitewood Creek. Some forms of aquatic life could probably be reestablished. Semi-aquatic wildlife would be benefited nearly the same as with I-E(1). It should be noted that most species of semi-aquatic wildlife are not dependent on cold water fish. Impact of HMC treatment operations would be similar to I-E(1).	Impact of collection system would be similar to alternatives I-E(1) and I-E(3). Development of a 9000' effluent pipeline from HMC to the proposed tailings pond would traverse steep forested topography resulting in loss of many trees. In addition the combined domestic and industrial waste tailings pond would inundate 200 acres of Grizzly Gulch. Construction of the dam, access roads and irrigation system would also cause losses of natural vegetation and drive reclusive wildlife to other areas. These impacts would be greater than for the other alternatives because the joint application site would be larger. It is felt that this system has a slightly better chance of establishing a cold water fishery in Whitewood Creek. The benefits to semi-aquatic wildlife would be similar to I-E(1). The operation of this alternative is expected to cause a significant change in vegetation on the application site. Drier species would probably be replaced by more water tolerant plant life. Tree loss caused by blow-down is expected. Impact on wildlife is uncertain, but changes should follow in response to changes in vegetation. Deer are expected to forage on the more lush vegetation resulting from system operation.	No construction impact. Whitewood Creek would remain a highly polluted and dead stream system. As important, the Belle Fourche and Cheyenne Rivers would continue to be degraded by tailings discharged to Whitewood Creek. Whitewood Creek would remain worthless as a habitat for aquatic and semi-aquatic wildlife.	I-E(1)* I-E(3), III-E(1) IV

* This ranking considered that HMC would build a physical-chemical plant in Lead. If HMC developed a separate land-based treatment system near Grizzly Gulch, the impacts of the three alternatives would be similar and the ranking would have to be changed.

ENVIRONMENTAL IMPACT, continued

PARAMETER	I-E(1) LOWER DEADWOOD AWT	I-E(3) LOWER DEADWOOD SECONDARY	III-E(1) LAND-BASED TREATMENT NEAR GRIZZLY GULCH	IV NO ACTION	RIVER CREEK (Most Preferable to Least)
Sensory (Aesthetics, Odor and Noise)	Construction of collection system would increase local noise and congest roadways. Inhibition of vehicular traffic could impact the local tourist industry. Accelerated construction of the collection system would be an inconvenience during the planned Bicentennial Celebrations. Construction activity for plant construction would have a noise and visual impact on lower Deadwood. Development of a STP in lower Deadwood would represent a long-term visual change. The plant would be visible from U.S. Route 85, the major point of entry (exit) to the Lead-Deadwood Area. Should MMC develop a land-based treatment system visual impacts would be similar to III-E(1). Regardless, the MMC tailings pond would have an adverse impact on aesthetics in Grizzly Gulch. Persons entering the Lead-Deadwood area on U.S. Route 85 and those attending events at the rodeo grounds may be slightly affected by odors during plant failure. Plant operation would improve the appearance of Gold Run and White-wood Creeks. The creeks would run clear (as opposed to slate gray) through the Lead-Deadwood area. Odors from raw domestic and industrial waste outfalls would be eliminated.	Construction impacts would be nearly analogous to those of alternative I-E(1). This plant would be somewhat smaller and therefore less conspicuous than I-E(1). Potential odor impacts would be equal to I-E(1). Impacts of MMC activities would be similar to I-E(1).	Impact of building collection system would be same as for alternatives I-E(1) and I-E(3). Construction of force main between lower Deadwood and Grizzly Gulch may encroach on U.S. Routes 85 and 385. This system has by far the greatest construction requirement. This activity would have a significant visual effect on both Grizzly Gulch and the effluent application site. The operation of this system would result in a permanent visual change: 1900 acres would be affected. Roads, irrigation laterals and tailings pond would adversely affect the natural forested landscape, and changes in onsite vegetation would be noticeable. These impacts are lessened due to the remoteness of, and limited access to, the project area. Conversely, implementation of this system would obviate installation of a treatment plant at lower Deadwood. However, pump stations would be built at lower Deadwood and at Pluma. Compared to a treatment plant, pump stations are inconspicuous. Improvements in local aesthetics would be similar to those for alternative I-E(1).	No impact. No visual changes. Whitewood Creek would remain its slate gray color. Odors from raw domestic and industrial waste outfalls would persist. This impact of maintaining Whitewood Creek as an open sewer is difficult to assess. But, it is possible that the creek's condition subconsciously adversely affects community pride as well as the area's desirability. The odor and appearance of the creek is, in all certainty, objectionable to tourists.	III-E(1) I-E(3) I-E(1) IV

ENVIRONMENTAL IMPACT, continued

PARAMETER	I-E-(1) LOWER DEADWOOD AWT	I-E-(3) LOWER DEADWOOD SECONDARY	III-E(1) LAND-BASED TREATMENT NEAR GRISSELY GULCH	IV NO ACTION	RANK ORDER (Most Preferable to Least)
Land Use and Development	The implementation of this system would not entice major land use changes or additional growth in the Lead-Deadwood area, because the plant has been sized for a stabilized population. However, implementation of sewage treatment could reverse the recent declines in the Lead-Deadwood population. Without federally acceptable sewerage service, the area is ineligible for FHA assistance programs. Consequently, the District is experiencing a serious housing shortage. Use of the lower Deadwood site for wastewater treatment would preclude other uses. Land is currently zoned industrial in the Deadwood Comprehensive Plan, so legal land use conflicts are not expected. However, conflicts with the rodeo grounds are possible. HMC is not expected to have land acquisition problems in Grissly Gulch because the tailings pond and land application site (which would be much smaller with a separate industrial system should HMC select this option) would be built on property wholly or partially controlled by the company. Land acquisition conflict with the South Dakota Department of Highways is expected.	Impact on development would be similar to that of alternative I-E(1) if stream standards are revised and the implementation of secondary treatment is acceptable to State and Federal regulatory agencies. Land use issues same as for alternative I-E(1).	Impact on growth is similar to that of other alternatives. Part of the effluent application site is public land and is presently available for public recreation. Implementation of this plan would preclude continued use of this land for public outdoor recreation. Land use conflicts are expected. Negotiations and acquisition of land from three Federal agencies are expected to be difficult. In addition, special interest groups and conservation groups are expected to lobby against the project.	The no action alternative would obviously not entice population growth. By the way of contrast it may perpetuate declines in population, due to the area's ineligibility for FHA assistance and resultant housing shortages.	I-E(3) I-E(1) III-E(1) IV

ENVIRONMENTAL IMPACT, continued

PARAMETER	I-E(1) LOWER DEADWOOD AMT	I-E(3) LOWER DEADWOOD SECONDARY	III-E(3) LAND-BASED TREATMENT NEAR GRISSELY GULCH	IV NO ACTION	RANK ORDER (Most Preferable to Least)
Social	Benefits would include: (1) protection of public health; (2) addition to the desirability and value of private property; (3) restoration of Whitewood Creek, possibly to a cold water fishery; (4) eligibility of Lead and Deadwood for HUD assistance loans (it should be recalled that there is a shortage of housing in the project area, partially due to the area's ineligibility for HUD money because of lack of an adequate sewerage system); (5) protection of downstream water resources, namely the Belle Fourche and Cheyenne Rivers and the Oahe Reservoir, from further degradation; and (6) bolstering of the local economy due to influx of construction dollars. The major detriment of this system is annual cost. A household cost of \$17.36 per month may be burdensome to local users. Second, the high capital cost of providing advanced waste treatment at Lead and Deadwood may commit Federal and State funds away from other pollution problems.	Benefits would be similar to alternative I-E(1) with the exception of a cold water fishery and the possible recreational amenities accompanying it. However, none of these potential benefits could be realized unless stream standards were revised and secondary treatment was approved by involved regulatory agencies. This system has the lowest annual cost for the District with a monthly cost of \$10.11 per household.	Benefits similar to alternative I-E(1). Like alternative I-E(1), the major disadvantage of this system is high monthly cost, \$17.10. This alternative has the highest capital cost. Use of this capital in the Lead-Deadwood area may thwart implementation of other wastewater projects. Of the three alternatives, this represents the greatest financial commitment.	Benefits include: (1) avoidance of construction impacts associated with the three proposed alternatives, and (2) no capital expenditure, i.e., no annual cost to local community. LEAD AND DEADWOOD WOULD REMAIN INELIGIBLE FOR HUD ASSISTANCE PROGRAMS. LIKEWISE, THE DISTRICT AND HMC COULD BE FINED UP TO \$25,000 PER DAY FOR VIOLATION OF THE NPDES DISCHARGE PERMIT.	I-E(3) I-E(1), III-E(1) IV